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Even Electricity Moves Slowly There. A FOREIGN dynamo is advertised with the claim that "the commutator sections pass the brushes so rapidly that there can be no sparking." We do not know that kind of electricity here, nor have we much use for it in America. Perhaps that has been the reason why rapid transit by means of electric railways has made so little progress there.

Multiphase Currents. EVER since the application of the three-phase system on a large scale at Frankfort and at Heilbronn, in Germany, numerous opinions have been expressed and statements made concerning the relative value of this system as compared with the ordinary ones. That the motors have certain advantages over not only the simple alternating current motors but also over those for continuous currents, cannot be denied by any one who has seen them used under the most trying circumstances. Whether their good features are counterbalanced by attending disvantages remains to be seen. The second point in question is the line or the line loss. This is discussed in our present issue in a paper by Mr. Winand.

Progress of the Niagara Falls Plant. THOSE who are interested in the Niagara Falls power plant, which has been described in detail in our columns, will be pleased to hear that the large tunnel which is to be the tail race for the turbines is now finished. The engineers expect to have the turbines and all the rest of the equipment ready to run about March of next year. It is interesting to note that over half the power which is to be developed will be transmitted by electricity. It has been estimated that in the city of Buffalo there is at present a total consumption of 45,000 h. p. The Niagara Falls plant will therefore be able to furnish the whole of the city of Buffalo with all the power it needs at present, and according to the estimates given there will be 30,000 h. p. left for transmission to other points.

Unjust Electric Railway Reports. THE American Society of Civil Engineers, or at least its publishing committee, do themselves no credit by publishing in the last number of their *Transactions* a paper on a power and efficiency test of an electric railroad made as long ago as 1889. Had this paper been offered as information of historical interest to show what great progress had been made since those early days, it might have been justifiable, but no such qualifications appear in the paper. Although the tests which the paper describes may have been well made and were fair at that time, it is certainly unjust to the electric railway of to-day to have this report appear as if it was at all representative of the roads of to-day. The electric railway was just being born at that time and, like all things, it evolves and develops, but it is not created perfect at the start. An electric railway such as the one there tested is so old and obsolete a model that no company would think of constructing one like it at the present time. There is, perhaps, no other industry which has developed so rapidly as the electric railway. It is to be hoped that the members of that society, prejudiced as they may be against electric railways, will understand that this report is no criterion of what is being done to-day, and that the only value it now has is as a historical record. "Gramme type motors of 220 volts" were used; the power consumed varied from four to eight horse power, while the efficiency from the trolley to the wheel periphery was 24 to 56 per cent. What would the total efficiency have been, and at 220 volts, too?

A Civil Engineer's Views on Electric Railways. IN a paper recently read before the American Society of Civil Engineers on motive power for street railways, some rather sweeping statements are made which will be interesting reading matter to electric railway companies, showing them how much "missionary work" is still to be done. Little comment is necessary and we will therefore merely quote a few simple statements, which will speak for themselves. The author of the paper considers it almost axiomatic "that no system of motor suitable to all circumstances has yet been devised, and probably never will be." He says there is a "vast waste of power in transmission or transformation . . . in every system thus far popularized." After a careful and "unbiased" study he concludes "that steam without transformation is the cheapest power that can be used where fuel can be had at reasonable cost, and is destined to be the street motor of the future." He gives electricity the credit of being the cheapest when produced by water power, and says that "it will then remain as now a popular motor;" he also states that compressed air will be the cheapest and best for tunnels and underground lines "where electricity is not practicable" Has he never heard of the City & South London road, nor the projected Central road? He agrees with a number of other writers in saying that cable roads are best for hilly towns and steep grades. After quoting, among other statistics, some that are favorable for electric railways, he states, "it would appear that these figures were reached by exhibiting as accomplished facts the promises of the electrical enthusiasts who, it is said feelingly, have acquired the noble art of making hay while the sun shines." He claims that "electric systems waste in losses a very important percentage of the steam generating power. How much it is not possible to say without raising the hue and cry of contradiction." He thinks a system which has a total efficiency of 50 per cent. of the steam power generated at the central station has extraordinary "luck" in its successful economy; note that it is "luck" if not "skill" to which the efficiency of the electric railway is due. "After careful investigation among a tiresome mass of inventions" (why not include reports on existing roads in such an investigation?), he finds only "two systems which seem to promise . . . the street motive power of the future;" these are compressed air and compressed steam; to use a homely but expressive phrase, electricity "is not in it." He goes on at some length describing these two systems, both of which are already twelve years old. Compressed air roads in France, he states, have been operating successfully for twelve years. But if they have been successful it would be interesting to know why they have not made more progress during those twelve years. In speaking of a certain particular make of compressed steam motor he says that "a fair ground for hope exists that we have at last the motor best adapted to urban travel." It may be of interest also to quote here from a letter which he received from the Baldwin Locomotive Works, in which they say regarding these motors that "many roads which are at present operated by electricity, as well as other roads which are unable to obtain electrical franchises, and cannot make the expenditure involved by the cable, will be likely to adopt them." What a great waste of money it has been to introduce electric railways if they are already about to be abandoned in favor of another system! While we do not wish to say that electric traction will never have a formidable rival in its field, yet it does seem to us that in view of the good work which has been done in the development of the electric railway, that at least some of these statements are unjust, to say the least.

Electric Quacks and Impostors. IN the early days of electrical engineering, when dynamos were invariably painted red, and when everybody thought electricity such a wonderful thing that nothing seemed to be too marvelous to be accomplished by it, many impostors reaped a rich harvest by making use of the ignorance and almost childish confidence which the public had in new and startling electrical inventions, to force upon them all sorts of trash, claiming for it almost supernatural qualities. The great success which quack doctors have had with their patent medicines is very encouraging to a class of unscrupulous electrical impostors, whose name and reputation have no value to them, and the astonishing amount of confidence which an easily infatuated public has in high sounding schemes and claims, which a more conservative class of people tell them are not within the limits of possibility, makes the ignorant and confident public excellent prey for these impostors. One of the achievements in the modern development of electrical engineering might be said to be the very material reduction of the number of such impostors, but as there are still plenty of willing victims left there is even at present quite a field for such quacks, though it is appreciably less than it used to be. One of the most striking features of the electrical exhibits in the Paris Universal Exhibition of 1889 was the total absence of the primary battery fiend who claimed to get more energy out of his battery than was contained in the materials used. Many people who claim to be intelligent seem to think that money is easiest earned with things that are stated to be impossible by those who ought to know. In a case which came to our notice not very long ago, an inventor claimed to have devised a motor whose efficiency was 120 per cent., and he made the regular brake test before his capitalists, allowing them to make the readings and calculations themselves, to show that his claims were correct. His capitalists, who thought that they had a prize, were at first afraid to consult an electrical engineer about it, fearing he would destroy their hopes, but they finally did so, and were shown by him that the speed counter which had been used registered double, and that the motor was, therefore, a very poor one. Notwithstanding this exposure, however, the invention was afterward sold to some Western victims for a fat little sum. In another case, which has just come to our notice, a quack, who is at present reaping rich returns for his dishonesty from among a class of sick women and ignorant men, is selling a $25 medical cell, small enough to be put in a vest pocket, which he claims will give current by placing it in cracked ice, but the most wonderful part is that it requires only one wire to lead off the current, there being no provision, not even one ground connection for the return circuit; the cell is placed on a carpet and the victim in a bed—no better insulation could be desired. If space allowed, we might cite many other cases to which our attention is being called almost daily. We will merely call attention here to a letter in another column, giving the experience of a victim who bought one of the "wonderful primary batteries." No one can deny that there are manufacturers of primary batteries who are doing an honest business with cells, the claims for which are not unreasonable, and it is to their interest that attention should be called to the impostors. The opportunities for fraud are particularly favorable in the primary battery business, and it is therefore to the advantage of those whose claims are modest but honest, to have the public know that their batteries are really better than those for which such pretentious claims are made. Our advice to the buyer is that when a battery company makes claims that seem unreasonable he had better first consult an electrician and follow his advice.

Fire Risks in Electric Lighting.

To the Editors of the Electrical World:

I am in receipt of your issue of the 8th inst. and have noted the editorial remarks which you make upon my communication to *The Electrician* of Sept. 16, with reference to fire risks and rules and my opinion upon American fittings. Your remarks state that you consider the wholesale condemnation of wires on the ground which I give as unjust, although you give me credit for my good intentions not to do injustice to American manufacturers.

I think that the inference which you draw from my letter is an incorrect one, and I feel that it is due to me that my remarks should be criticised in the sense in which they are meant, and that their true meaning should not be perverted. If you read my letter again you will find that I have not condemned the wires made in America; what I said was that I find that there are a multiplicity of different qualities of wires made and advocated in America, which proves to me that American manufacturers and contractors have not yet made up their mind as to proper standards, and my expression that they are "very much at sea" over this question is all I have said upon this particular question. I believe this statement is in accordance with the knowledge (I must confess somewhat limited) which we possess here upon the matter.

I may say that here in England we have established certain standards of insulation of electrical wires to be used inside houses. This standard insulation is the following: "Insulated pure India rubber, then vulcanized India rubber, India rubber coated tape, the whole vulcanized together, braided tarred flax, and coated preservative compound." And it is now universally adopted throughout England. There are but three qualities made to this specification which only differ as to the thickness of the India rubber, and are distinguished by their respective nominal insulation resistances of 300, 600 or 2,000 meg-ohms per mile.

I do not say that American manufacturers cannot make as good wire or even better than that made here to this specification, but what I wish to infer is that it is much more to the advantage, both of the manufacturer and the contractor, to have some recognized standard of the insulation of wires than to have a multiplicity of the same. Moreover, as the vulcanized wires used here have in actual practice proved to give us all the insulation we require, and also immunity from fires, beside standing the test of time, we have no reason to be dissatisfied or to wish to alter the same. Your remarks upon what I have said regarding American porcelain, and the fittings made upon the same also call for some justification on my part. It may be that the American fittings which I have seen and tested are now obsolete (for improvements now follow each other in quick succession) and I should certainly feel grateful to any manufacturer in America, if he were to send me his latest production in this particular line. I am desirous to justify the statements which I have made; long descriptions in a newspaper will, however, hardly bear me out. I feel also that the matter is one of some importance to the general electrical profession and that an interchange of the latest productions might be useful to you in America as well as to us here, and therefore I have decided to send you, together with this letter, a few of the patterns which I have manufactured here out of the china made in the English potteries. I shall be gratified if you will examine them or submit them to any expert, or publish their description and result of tests. The patterns I am sending you consist of: First, one switch (link type). Secondly, one switch (Byng type). Thirdly, one concentric wall plug. Fourthly, one double pole cut-out. Fifthly, one brass lampholder. Sixthly, one china lampholder.

These samples speak for themselves, and I only wish to draw your attention to the following general features: There are no conducting metal parts at the back; a china insulating wall divides the two poles; flexible cord is lead through holes in the china wall, which carries the weight of the pendant; all conducting terminals, etc., are covered.

I hope that this communication of mine will considered by you as some justification of what I said, and I can only add that it is far from me to wish to do American manufacturers any injustice. On the contrary I can assure you I have written my communication to you and to *The Electrician* only with the desire of conferring some benefit upon the electrical trade in general.

Yours truly, G. Bins Wanger.

London, Eng., Oct. 21, 1892.

An Experience with a Wonderful Primary Battery.

The following is an extract from a letter which one of our correspondents in India sent to an American primary battery company after expending $150 on its goods:

"We have opened the four barrels of goods you shipped us out, and have given the contents a fair trial. As we see from your pamphlets and circulars that a great number of your customers favor you with their experience with your battery we feel constrained to do the same, though we doubt if you will publish it. We may say that we are not novices with primary batteries; we have been making them and experimenting with all kinds for the past 12 months.

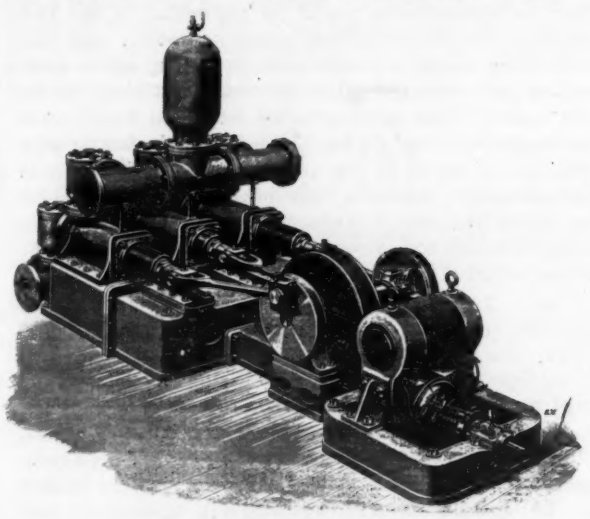
"We must first pay a tribute to the genius who packed this consignment—the idea of putting 10 pounds of a highly deliquescent depolarizing salt in a paper bag just on top of of a motor is unique, particularly when the whole lot were in a barrel making some 12,000 miles of a sea trip. The condition of the motor when we took it out from under the paper bag of semi-liquid salt was also unique.

There are two points of view from which a battery can be criticised, viz., the mechanical and the electrical. First, mechanically, your battery is one of the most curious we have ever seen, and the construction of an open, round glass jar on the bottom of which a porous pot cannot be made to stand upright anywhere is interesting. We think, however, the highest flight of genius in the mechanical construction has been arrived at in the carbon connection. A light brass screw which can only be moved with difficulty by a screw driver is an entirely new feature, and the pleasure of connecting up cells with a screw driver used in the top of an inebriated porous pot which will not stand upright anywhere in the outer glass jar, must be experienced to be appreciated.

"Now for the battery electrically. Your advertisements and circulars say, "No Fumes." Directly we set eyes on the depolarizer we wondered at this, but once we had the battery at work, and the dear old nitrous fumes we know so well flooded the whole room and made the use of the battery in any living apartment an impossibility, we appreciated the satire of this statement. We also understood your battery was a marvel of constancy—well, of course, opinions may differ. If, after being set up for three days a cell which is supposed to be a 300-ampère hour one and capable of giving 40 ampères and 1½ volts all along its run, falls down to eight ampères, although it has not done one hour's work during those three days, and only gives one volt, is considered a marvel of constancy—you are right it is!!! We have, however, common sulphate of copper cells made in our back yard by a native carpenter on ten cents a day which can do infinitely better than this."

Electric Pumping Plant at the North Seaton Colliery.

Messrs. Ernest Scott & Mountain, Close Works, Newcastle-on-Tyne, England, have lately constructed a complete pumping plant for the North Seaton Colliery, which is



Electric Pumping Plant.

shown in the accompanying illustration, for which we are indebted to the *Iron and Coal Trades Review*. The pumps have been built to deliver 250 gallons of water per minut through 1,300 yards of 8 inch pipe, against a head of 50 feet when running at a speed of 30 strokes per minute; but as the speed can readily be increased to 50 strokes per minute, the capacity of the pumps is then 420 gallons per minute, and the pumps have further been constructed of a suitable strength to pump against a head of as much as 200 feet if necessary. The pumps are driven by an electric motor, the dynamo and engine for supplying the electric current being placed at bank, and the current from the dynamo being conveyed to the motor through 2,700 yards of concentric cable. The engine for driving the dynamo is of the vertical type, with cylinders 13 inches in diameter, by 10-inch stroke, and will run at a speed of approximately 200 revolutions per minute. The steam is taken from the colliery boilers which adjoin the house containing the electrical machinery. Arrangements are being made so that a second engine of the same size will be added later, which will be used for driving the dynamo lighting the colliery, as the dynamos will be duplicates, both machines being arranged for either driving the motor or running the lamps, and there will then practically be a duplicate plant.

The dynamo is of Messrs. Scott & Mountain's improved type for mining purposes, and is capable of giving an output of 65 ampères at an electromotive force of 300 volts when running at a speed of 800 revolutions per minute.

The pumps shown are of the three-throw type. The rams are of gun metal, 9 inches in diameter, by 15-inch stroke, and work at a speed of 30 strokes per minute. The crank shaft and connecting rods are of steel, and all bearings are adjustable and of extra length. The pumps are driven by means of a "Tyne" electric motor of Messrs. Scott & Mountain's mining type, capable of giving 20 effective horse power on the motor spindle when running at a speed of 720 revolutions per minute. The power from the motor is transmitted to the pumps through worm gearing, the worm being of wrought iron case hardened and the worm wheel of phosphor bronze. A thrust bearing is provided for taking the thrust of the worm, the worm itself being arranged to run in a bath of oil, so that lubrication is provided.

The Fritsche Dynamo.

One of the most remarkable developments of the drum armature is that due to Mr. Waldemar Fritsche, of the firm of Messrs. Fritsche & Pischon, of Berlin. Those who have had experience in the actual design of drum armatures, says *Industries*, of London, know that the end connections, especially in the two-pole machines at present in fashion in this country, are very complicated and unwieldy. The cost of power for excitation and of copper for the fields is also serious, because the air gap is considerable, and a strong field is desirable. The air gap might be reduced by using a Pacinotti armature if the field poles did not then become hot; or by adopting hole windings if that did not

Fig. 1.—The Fritsche Armature.

cause sparking at the brushes. A two-pole hole-wound drum machine would also be troublesome to make neatly unless the output were very small for the size of the armature. Mr. Fritsche has minimized these difficulties by one device. He uses a winding which has no "connectors" at the ends of the armature, and in many cases employs iron as the conductor, so that the air space is very small. Sparking due to excessive cross induction is avoided by making the machines multipolar, so that the pole faces are fairly narrow. The winding in the drum armature is shown most clearly in Fig. 1. This belongs to a four-pole machine shown in Fig. 2. It will be seen that the armature conductors lie spirally, and make a quarter of a turn in the length of the armature. The drum is wound with two layers of conductor, and the inner layer, which cannot be seen, is wound in a left-handed spiral of the same pitch. There are no connectors. The ends of the conductors of the outer layers are soldered directly into the commutator bars, and the ends of the outer and inner conductors are also connected together. The armature circuit thus forms a continuous winding round the armature, the turns being in series; four lengths of conductor—two outside and two inside—thus forming a circuit extending right around the armature. The pole-pieces are made diamond shaped instead of rectangular, as the corners would obviously be useless. The reduction of the pole area is the only drawback to this winding, and it appears to be quite outweighted by the perfect simplicity of construction. The absence of end connectors also admits of the construction of a large commutator, which is a very important feature. This allows sufficient room for central ventilation. The armature does not project much beyond its field, so that the bearings are not wide apart and the armature firm and rigid.

If we imagine the iron core drawn out of the armature just described we should have a sort of tube of conductors

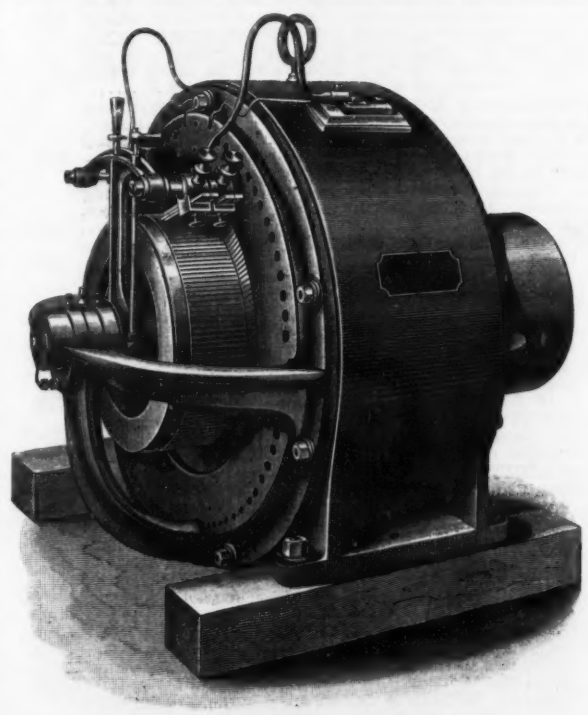
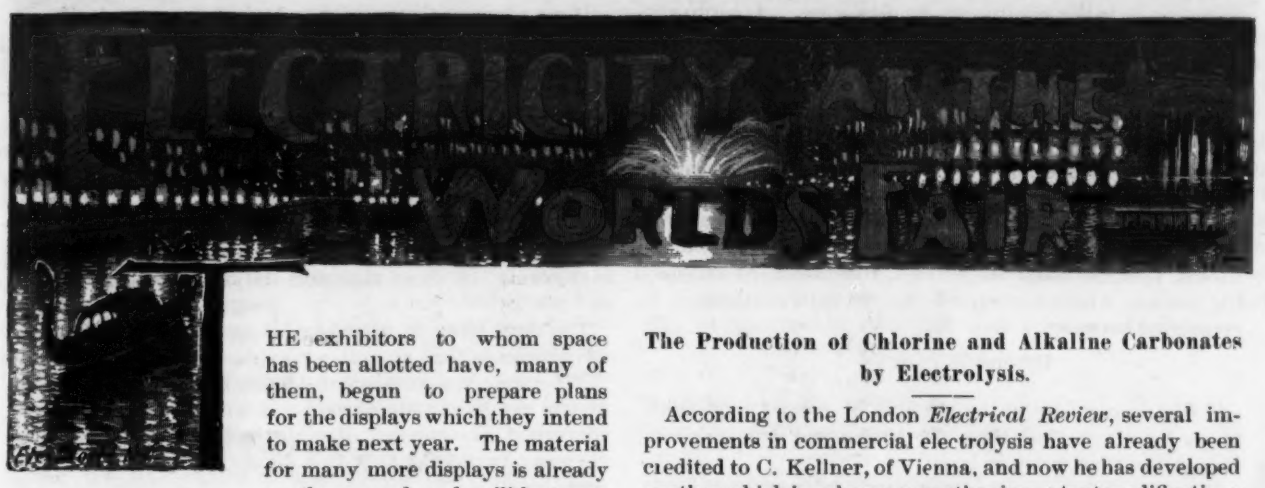


Fig. 2.—The Fritsche Dynamo.

with a commutator at one end. If this tube be widened to the pulley end we get a core with the armature at the small or apex end. If it be widened still further we eventually obtain a disc with the commutator at the centre. This is one form of the Fritsche flat-ring armature.

The field resembles that of an alternator, having N and S poles opposite. The poles are cut away to suit the peculiar shape now taken by the conductors. Mr. Fritsche, however, replaces the copper by iron slips. The armature so produced is simple to make, very strong, easy to insulate, and splendidly ventilated.



HE exhibitors to whom space has been allotted have, many of them, begun to prepare plans for the displays which they intend to make next year. The material for many more displays is already on the ground, and will be transferred to its proper place as soon as the buildings are ready for work of this character.

The buildings and their decorations are now so far completed that it is possible to obtain sketches of some of the more important details. Our illustration shows one of the large groups of figures that are placed on the Transportation Building. This particular group is known as the electrical group, and is intended to represent the electrical industries of the day, as other groups represent the various industries allied in one way or another to the transportation business of the country whose progress in the last half century will be elaborately set forth in the exhibits made in this building. The group is placed over one of the entrances on the eastern side of the structure facing the lagoon and, further beyond, Lake Michigan.

The subject of a conference of teachers of engineering at some time during the World's Fair has recently been under discussion by a committee appointed by President Bonney, of the World's Congress Auxiliary. Of this committee Prof. Ira O. Baker is chairman, and he has announced that the substance of the conclusions approved by the commit tee are as follows:

It was decided to devote the afternoons of the week ending July and beginning August to the papers and discussions touching on the pedagogical side of engineering, since the forenoons of this week will be given to carrying out the programme of the General Engineering Congress.

The conference on educating engineers is a sub-division under the Congress of Engineers, and, though electrical engineering and architecture do not come technically under the same head, the committee, believing it would be their wish to unite with the civil, mechanical and mining engineers in this matter, outlined a programme in which all should be equally represented.

It was the judgment of the committee that a part of the meetings should be devoted to papers on subjects of common interest to all the engineering divisions, while the rest would be given to sectional meetings in which one or more branches of engineering would take part according to the nature of the subjects under discussion.

A partial list of desirable subjects for papers was made out, and, as far as possible, professors indicated from whom papers would be asked.

The small amount of time for these papers, and the desirability of having the discussions following very free and full, suggest a brief, clear statement of the conditions and bearings of the subject rather than an exhaustive treatment.

The aim of the committee was to distribute the papers on subjects of common interest among the five professions and among the institutions giving engineering courses as equally as possible.

The small number of such papers and the large number of schools brings the burden of the papers on only an occasional institution. It is, however, the desire of the committee to enlist the co-operation of every teacher and professor in engineering as to suggestions for papers and subjects for discussion.

Every teacher or practicing engineer interested in the educational side of engineering in this country, or in any country, is invited to be present at the meetings, and to take part in the discussions.

An outline of the conference will be found in the circular of the Engineering Congress, which will appear soon.

THE ELECTRICAL GROUP ON THE TRANSPORTATION BUILDING.

The Production of Chlorine and Alkaline Carbonates by Electrolysis.

According to the London *Electrical Review*, several improvements in commercial electrolysis have already been credited to C. Kellner, of Vienna, and now he has developed another which involves some rather important modifications of principle, as well as of detail. He can produce chlorine gas and alkaline carbonates simultaneously from a heated solution of an alkaline chloride. This solution is caused to rapidly circulate in two separate streams through an electrolytic decomposing apparatus. One stream is conducted past the anodes, and is mixed with a small quantity of sulphuric acid, or of a sulphate of the chloride base, and this stream after leaving the anodes is conducted through a vessel containing fresh solid alkaline chloride, whereby the liquid is again completely saturated before returning to the anodes The other stream is conducted past the cathodes of the apparatus, and then is cooled in contact with more solid alkaline chloride, while at the same time it is subjected to the action of carbonic acid gas, whereby a carbonate of the alkali present is formed and precipitated from the solution, the latter being afterward conveyed back to the cathode cells again. To facilitate the escape of the hydrogen which is set free, carbonic acid is introduced into the cathode cells. The electrolyte is also maintained at such a velocity and temperature as will prevent carbonates from settling within the decomposing apparatus. There is a curious arrangement of diaphragms set in frames and connected by passages through which the electrolytes circulate and the liberated gases escape. These diaphragms are made of a permeable fabric, or of porous clay, the pores of which are filled with a gelatinous material mixed with a solution of salt corresponding to that to be decomposed. This prevents injurious mechanical diffusion from one cell to another of the liquids treated, and is said also to facilitate the circulation of the ions. The electrodes are made by mixing together powdered retort carbon and a thickened solution of wood cellulose in zinc chloride ; this mixture is kneaded to a paste, washed, molded and then heated in a muffle, impregnated with a hydrocarbon, and then heated again ; the latter process being repeated several times. Kellner also uses electrodes, the pores of which are filled with peroxide of lead, obtained either by covering them with a layer of litharge and ammonium sulphate mixed, or by boiling them in a saturated solution of lead acetate, and afterward electrolytically transforming the deposit into peroxide of lead.

The Telephone in Switzerland.

The increase in the number of telephone lines, says the *Economiste Français*, since the new tariff came into operation, about two years ago, has been very remarkable. Previous to that there were 61 telephone exchanges, with 6,944 stations and a revenue of about $214,000, the annual subscription being $29, with no limit to the number of con versations. The new tariff lowered the subscription to $15.50, and the result is that at the beginning of the present year there were 101 telephone exchanges, with 12,595 stations, this being equivalent to an increase of 81 per cent. The length of line is 3,225 miles. The new law stipulates that each subscriber shall be entitled to only 800 conversations in the course of the year, and pay one cent for each one over that number. The development of telephone communication has, as might be expected, checked the increase in telegraphic communication.

Recent Tests of Incandescent Lamps.

Some interesting results of a long series of experiments by M. Ch. Haubtmann on various types of incandescent lamps were recently published in *L' Electricien*. The lamps were on circuits of a difference of potential of 102 and 110 volts. The lamps belonging to the Compagnie Francaise (16 c. p.) had at first a luminous power of 15 candles, which fell to 5 candles after 1,000 hours. The mean specific consumption in watts per candle is 2.8. Lamps of 10 c. p. give 10.47 candles at first and 5.2 after 1,000 hours, with a mean consumption of 3.6 watts per candle. The Siemens lamps give 19.8 candles at first and 11.3 after 1,000 hours with a mean expenditure of 3.8 watts per candle. For the Gabriel 16 and 10 c. p. lamps, under the same conditions, the luminous powers varied from 18 to 15 and from 13.5 to 8.56 candles with respective mean consumptions of 3.9 and 4.1 watts per candle. The Swan-Edison lamps (French manufacture) had luminous powers of 18 candles when started and 13 after 1,000 hours, with a mean consumption of 4.18 watts per candle. The Swan-Edison lamps (English manufacture) only varied from 18.4 to 13.9 candles with a mean expenditure of 3.7 watts per candle. The Khotinsky lamps fell from 16.5 candles at starting to 13 after 1,000 hours with a mean expenditure of 3.9 watts per candle. The Cruto lamps gave 16.4 candles at starting, 11 candles after 1,000 hours; expenditure, 3.7 watts per candle. The Allgemeine Gesellschaft 16 and 10 candle lamps, and those of the Société Hongroise and the Société de Zurich, gave the following figures:

Make.	Candle Power.		Mean consum'tion in watts per candle.
	At Starting.	After 1,000 hours.	
Algemeine Gesellschaft—			
16 c. p.	15	8.8	3 12
10 c. p.	10	5	3.47
Société Hongroise—			
16 c. p.	21	13.25	3.8
Société de Zurich—			
16 c. p.	17.6	7.35	2.8
10 c. p.	12.92	9.7	3.3

Polyphased Currents.*

BY PAUL A. N. WINAND.

A MECHANICAL ILLUSTRATION OF POLYPHASED CURRENTS.

Before going over to the comparison of the amounts of copper required in line for the transmission of power by means of continuous, alternating and polyphased currents, and to the question of measurement of energy, it may be interesting to describe a simple mechanical model by means of which most of the preceding considerations can be shown in a tangible manner. It consists (Fig. 1) of two discs (shown as rings of wire with spokes) mounted in such a way that they can rock, without being allowed to turn, on their centres. Each disc is provided with a small central shaft perpendicular to its plane. A small crank is so connected to one of the shafts as to impart to it a circular conical motion around the main axis of the apparatus, which is the line joining the centres of the discs. The discs, in order to be prevented from rotating, may be connected to the frame by flat springs, or by strings (as shown), secured to their periphery and to a point of the frame situated at the same level as the centre of the disc. When the crank is turned the first disc rocks evenly in all directions, and each of its points has an almost straight up and down motion, which follows the sine law very closely; but the different points of the periphery reach their extreme positions successively. Their motions are of different phases.

If strings of equal lengths are stretched from corresponding points of the peripheries, from one disc to the other, they will have longitudinal motions following the sine law, and will represent the different currents (or electromotive force) of a polyphased system. The second disc, with its shaft, will follow exactly the motions of the first. Fig. 1 corresponds to a symmetrical five-phase system. Any system, however, can be represented by securing the

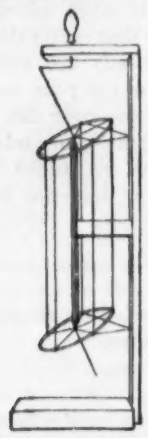


Fig. 1.—Model Showing Simply Successive Phases.

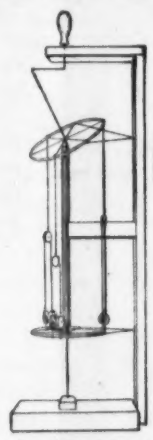


Fig. 2.—Model Showing Relative Phases of Star and Mesh Currents.

strings to corresponding points (not only at the periphery) of the discs.

The second general condition of polyphased currents is shown in the model by the mechanical analogon that the centre of gravity of the strings must be on the main axis.

With a slight modification the same model can exhibit the relations between star and mesh currents. Fig. 2 shows this for a symmetrical three-phase. Each string from the first disc carries at its end a small pulley. A continuous string (mesh string) is led over these pulleys and others passing to the second disc. If now the axes of the latter be held stationary in the main axes while the crank is being operated, the first-named pulleys will move up and down with the star strings, and the mesh string will have a motion of its own, which is different in phase in the different sections of this string, and also different from the motions of the star strings.

In each section the motion corresponds in phase with the current in the corresponding branch of the mesh combination, but its amplitude is double as compared with the motions of the star strings.

EFFICIENCY OF TRANSMISSION AND AMOUNTS OF COPPER.

The comparison in respect to the efficiency of transmission for a given line or to the amounts of copper required for obtaining the same efficiency has often been made between the alternating and the continuous systems.

We might, therefore, confine ourselves to comparing the plain alternating with the polyphased systems. I will, however, recall concerning the continuous system, that the same current (measured in both cases with a dynamometer) gives the same loss by heating in the same wire whether it be continuous or alternating, as long as the frequency is not so high as to produce an appreciable skin effect.

If the alterations follow the same law for current and potential, and if there is no difference of phase between the two, the rate of flow of energy is the same for continuous and alternating transmission when current and voltage are the same, and are both measured with instruments giving readings proportional to the mean square. The same line will then produce equal losses and efficiencies in both cases.

But it should be remembered that, if the sine law is followed, when the measured voltages are the same, the maximum difference of potential $\sqrt{2}$ times as large in the alternating as in the continuous transmission. Accordingly it requires twice as much copper to transmit, with the same efficiency, a given energy by alternating as by continuous currents, if the same maximum difference of potential is to be allowed in both cases.

It has been claimed by competent men that as far as insulation and danger are concerned, a higher maximum difference of potential is allowable on alternating circuits, the more so the higher the frequency. To what extent this is the case appears to be undecided yet, but it seems fair to assume that, for usual frequencies, the measured alternating voltage, which corresponds to 100 volts continuous, is comprised between

$$100 \text{ and } 70.7 \left(\text{or } \frac{100}{\sqrt{2}}\right)$$

and that, consequently, the amount of copper required is larger for alternating than for continuous transmission, though less than twice as large.

Whatever this proportion may really be, as everything is alternating in the polyphased systems, these doubts do not

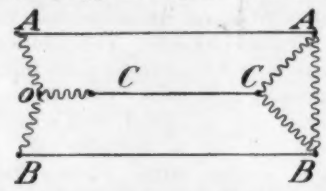


Fig. 3.—Thema of Three Phase Circuit.

apply to the comparison between plain alternating and polyphased transmission. A difference of phase between current and electromotive force, which would necessitate an increased amount of copper in the alternating transmission, would be just as disadvantageous in polyphased currents and would not change the relative values obtained for these two systems.

Everything being alternating, it might seem, at first, that there is no difference in the amounts of copper required for alternating or polyphased transmission with a given efficiency.

In reality, however, the polyphased systems are, generally, more advantageous (the three phase especially so) and this is due, broadly speaking, to the fact that the voltage on which the energy depends is not always the same as the voltage which has to be considered for insulation.

Fig. 3 represents a symmetrical three phase, one end being a star, the other a mesh combination. A-A, B-B, C-C are the line conductors. If we call V_c the voltage between O and A, and C_c the current (square root of mean square) in $A\,A$ we have seen previously that the voltage V_l between A and C for instance is

$$V_l = 1.73\ V_c \qquad (1)$$

and the current in $A\,C$ is

$$C_m = 0.577\ C_c.$$

It is obvious that the voltage which should be considered for insulation is V_l, because it is the highest that occurs between any two points of the system. But the voltage on which the energy depends, together with the current C_l in the line, is V_c. The total energy is

$$E_3 = 3\ V_c\ C_l \qquad (2)$$

and if R_3 is the resistance of each line conductor, the total loss of transmission is

$$H_3 = 3\ C_l^2\ R_3 \qquad (3)$$

For a plain alternating or two-phase system (Fig. 4) the voltage $A\,O\,B$ may be designated by $2\ V$, and there is no distinction to be made for insulation and energy.

$$E_2 = 2\ C\ V \qquad (4)$$

$$H_2 = 2\ C^2\ R_2 \qquad (5)$$

The alternating and three phase are of the same practical voltage when

$$V_l = 2\ V \qquad (6)$$

Substituting (1) in (6) gives

$$2\ V = 1.73\ V_c \qquad (7)$$

or

$$V_c = 1.154\ V$$

For comparing the cases where the same energy is to be

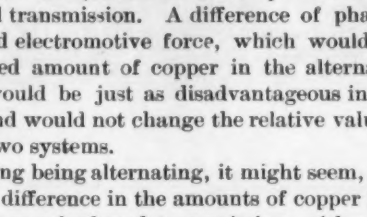


Fig. 4.--Thema of Alternating Circuit.

transmitted with the same efficiency, we have to equalize (2) and (4), and this, with (7), gives

$$C = 1.73\ C_l \qquad (8)$$

In the line the currents are 1.73 times as large in alternating as in three phase.

Equalizing (3) and (5) gives, with (8),

$$R_3 = 2\ R_2.$$

This means that the cross-section of the alternating line conductor is twice that of the three-phase conductor, and that the total amounts of copper are as 4 for alternating to 3 for three phase.

This result, in combination with the erroneous assumption that the alternating system is as advantageous as the continuous, has led to the wrong conclusion that the three-phase is more advantageous (for equal voltage) than the continuous transmission.*

If we compare the cases in which the current density is the same for both, then

$$R_3\ C_l = R_2\ C,$$

and substituting (8) in this

$$R_3 = 1.73\ R_2, \qquad (9)$$

which, with (3) and (5), gives

$$\frac{H_3}{H_2} = 0.866.$$

The percentages of loss are as 0.866 in the three phase to 1 in alternating when the drop of potential along the line is the same; (9) shows that then the amounts of copper are as 0.866 to 1.

The three-phase is, respecting economy of copper, more advantageous than any other polyphased system.

Whenever the number of phases is even, say $2n$, the system can be considered, as far as voltage and energy are concerned, as composed of n distinct ordinary alternating currents, by taking any two diametrically opposite currents together.

The amount of copper needed is, in this case, the same as for plain alternating transmission.

When the number of phases is uneven there is a saving in copper, but it is the smaller the higher this number is.

So while it is 25 per cent. for the three phase, it is but 9.5 per cent. for the five phase, and so on.

The four phase (often called two phase) gives no saving over the alternating, as the number of phases is even, when it is used in the symmetrical manner, with four conductors.

When it is worked by means of three conductors (one being a common return, in the well-known manner), the system is unsymmetrical and the amount of copper required is even greater, as will appear from the following:

In Fig. 5, OO represents the common return wire of such a system.

Let V_{4c} be the voltage between O and A, and V_{41} the voltage between A and B, then the currents in OA and OB are at

$$90^\circ \text{ or } \frac{\pi}{2}$$

difference of phase and the differences of potential also.

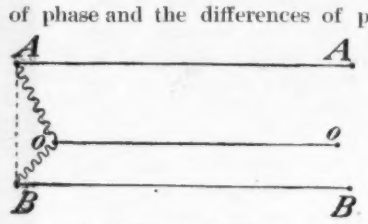


Fig. 5.—Thema of Unsymmetrical FourPhase With Common Return.

This latter, taken between A and B, will differ in phase by

$$\frac{\pi}{4} \text{ and } \frac{3\pi}{4}$$

from those in OA and OB and

$$V_{41} = 2 \sin \frac{\pi}{4}\ V_{4c}$$

or

$$V_{41} = \sqrt{2}\,V_{4c} \qquad (10)$$

Correspondingly the currents stand as

$$C_5 = \sqrt{2}\,C_4 \qquad (11)$$

if C_4 is the current in AA or BB and C_5 the current in OO. The energy is

$$E_4 = 2 V_{4c} C_4 \qquad (12)$$

and the loss

$$H_4 = 2 C_4^2\ R_4 + C_5^2\ R_5 \qquad (13)$$

If we assume the same current density in wires A, B and O, then

$$R_4 = \sqrt{2}\,R_5$$

which, with (11) and (13), gives

$$H_4 = 2 C_4^2\ R_4 + \frac{2}{\sqrt{2}} C_4^2\ R_4$$

or

$$H_4 = (2 + \sqrt{2})\, C_4^2\ R_4 \qquad (13a)$$

In order to compare this result with alternating transmission we have to assume

$$V_{41} = 2\ V$$

and equalize (4) and (12), (5) and (13a) this, together with (10), gives ultimately

$$R_2 = \frac{2 + \sqrt{2}}{4} R_4$$

The distance of transmission being supposed to be the same, the weight of each conductor is in inverse proportion to its resistance, and the total weights are as

$$8 \text{ to } (2 + \sqrt{2})^2$$

or

$$1 \text{ to } 1.457$$

for alternating and four phase.

As a conclusion of the preceding calculations, if the amount of copper required in the line when the same practical voltage is used and under otherwise identical conditions is 100 for alternating current, it would be 75 for three phase, 90.5 for five phase, 70.7 to 100 for continuous, 100 for four phase when symmetrical, and 145.7 for four phase with common return wire.

The last-named system requires, consequently, almost twice as much copper as the three phase.

If there is a difference of phase between the currents and potentials, the carrying capacity of the conductors in respect to energy is reduced as the square of the cosine of the difference of phase. But this applies to the alternating as well as to the polyphased systems.

It appears from all the preceding considerations, I think,

* A portion of a paper read before the Electrical Section of the Franklin Institute. For the first part see *Journal of the Franklin Institute* for October.

* This comparison relates only to the expenditure of copper for a given voltage, leaving altogether untouched the question of obtaining or dealing more or less easily with high voltages.

that the three-phase has decided advantages over the other polyphased and the alternating systems, and I will, therefore, confine my further remarks to the three phase.

Calculations similar to the above might be carried out for determining the relative losses and the weights of copper in case of a non-symmetrical system. This would, however, be of little practical interest.

MEASUREMENT OF ENERGY.

I shall now touch the question of measurement of energy in the three phase, but in this respect it is of actual value to consider also the general case of a non-symmetrical system having any differences of phase between the currents and potentials.

When the system is symmetrical the energy is

$$E = 3\ V_e\ C_1\ cos\ \varphi$$

or

$$E = 3\ V_1\ C_m\ cos\ \varphi$$

In this case, one reading of dynamometer gives directly the energy, but the instrument cannot generally be connected so as to give one of these results as

$$V_1 = \sqrt{3}\ V_e$$

the energy is also

$$E = \sqrt{3}\ V_1\ C_1\ cos\ \varphi$$

This formula enables to work with the instrument using the current in the line and the voltage between two line conductors.

As a rule, however, the system cannot be relied upon to be symmetrical.

Messrs. Siemens & Halske have devised a method and constructed an instrument for measuring the energy in this case.*

If the currents in the three line wires are of same magnitude, then by connecting an ordinary dynamometer so that one line current, say in AA, is used, while the volt

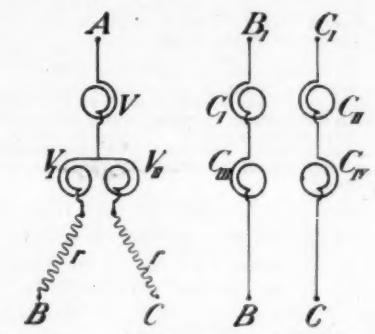


FIG. 6.—THEMA OF WATTMETER FOR GENERAL THREE PHASE.

coil is connected first to A and B, then to A and C, two readings are obtained, whose sum is the total energy.

Their special dynamometer gives this same result in one reading. Its volt coil consists of two separate windings which are connected to A, B and B, C.

If the three voltages, AB, BC and CA, were the same, instead of the three currents, and this is more likely to be the case in practice, the same result would be obtained by a dynamometer provided with a double current coil and a simple volt coil.

Mr. Goerges points out that if the two above-named readings of an ordinary dynamometer are equal, this shows in the present case that there is no difference of phase between current and potential.

He shows further that the energy of an unsymmetrical three phase can be obtained by six readings on an ordinary dynamometer or by three on the special Siemens instrument.

The above results, as well as a less complicated method, can be established by means of a very simple consideration, which proves useful also in other cases, namely:

That any three phase system can always be considered as consisting of two partly superposed independent alternating currents.

One is the current which passes through one line conductor, say AA, and flows back through the two others as a common return.

The second is superposed to the former in the two other conductors and does not affect the current in the first conductor.

Its value is, at any time, half the difference of the currents in B and C, while the value of the first is equal to minus half their sum.

The energy of the first is, at any moment, equal to the product of current A, and the mean difference of potential between A on one side and B and C on the other; that is, half the difference of the differences of potential β and γ between $A\ C$ and $A\ B$ when taken with their proper signs.

It is twice this part of the total energy which is measured by the special Siemens dynamometer when connected as above.

The energy of the second is equal to the product of half the difference of the currents B and C and the difference of potential a between B and C.

The first part of the energy can also be measured by means of an ordinary dynamometer, whose current coil carries the current A while its volt coil is connected to A and to the middle of a resistance stretching from B to C. This resistance need not even be non-inductive, provided its two halves be equivalent.

The second part can be measured by a dynamometer which has a double current coil.

* See the paper of Mr. H. Goerges, chief engineer of this firm, in *Elektrotechnische Zeitschrift*, 1891, p. 212.

Such an instrument could easily be so arranged as to enable us to measure also the first part with a proper change of connections. The total energy would then be given by two readings.

This result expressed by formulas is

$$E = A\left(\frac{\beta - \gamma}{2}\right) + \left(\frac{C - B}{2}\right) a, \qquad (13)$$

which is true as well for the instantaneous values as for their integral or the energy for one unit of time.

It is possible, however, to make an instrument which will

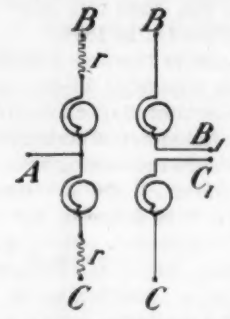


FIG. 7.—THEMA OF WATTMETER FOR THREE PHASE (ARON'S PRINCIPLE).

combine the actions of these two parts of the energy so as to give directly their sum or the total energy.

Fig. 6 is a diagram showing the working of such an instrument. The part on the left, which may be the movable one, contains one simple volt coil V and a double one, V_I V_{II}, the two halves of which are wound in opposite directions, and are connected to the equal resistances r r.

The part on the right contains two double current coils. The halves C_I C_{II} of the upper one are wound both in the same way, and act on coil V only.

The action is proportional at any moment to the sum of the currents B and C, or to current A.

The two halves, C_{III} C_{IV}, of the lower coil, are wound or connected in opposite directions, and act only on coil V_I V_{II}.

V_I V_{II} being of opposite directions give no resultant action for the current which flows in V, but their actions are added for the current flowing from B to C through the resistances r r in consequence of the difference of potential, a.

Dr. H. Aron has devised another method which is simpler yet, as it requires an instrument with four simple coils, acting in pairs, according to the diagram, Fig. 7.

He has modified his well known pendulum watt counter, according to this principle, for use on three phase circuits.

He has established this principle* by a very simple calculation, which I reproduce below.

If a, b, c represent the instantaneous values of the mesh currents, Fig. 8, and A, B, C; α, β, γ the same as before, then at any moment the total rate of flow of energy is

$$E = a\ \alpha + b\ \beta + c\ \gamma. \qquad (14)$$

The second condition of polyphased currents (in this case simply Kirchhoff's law) gives for three phase

$$a - c = B \qquad (15)$$

$$b - a = C \qquad (16)$$

and the third condition

$$\alpha + \beta + \gamma = O \qquad (17)$$

If we subtract the identical expression

$$a\ (\alpha + \beta + \gamma) = O$$

from (14) we obtain

$$E = \beta\ (b - a) - \gamma\ (a - c)$$

which, by substituting (15) and (16), becomes:

$$E = \beta\ C - \gamma\ B$$

The two products in this equation represent the instantaneous actions of the two pairs of coils in Fig. 17.

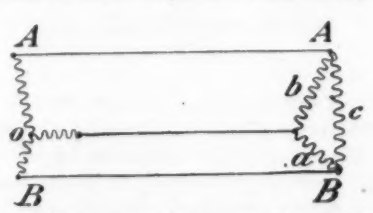


FIG. 8.—THEMA OF GENERAL THREE PHASE.

It does not seem very natural to subtract

$$a\ (\alpha + \beta + \gamma) = O$$

from (14), but the result can be reached equally well by writing instead of (15) and (16)

$$b = C + a$$

and

$$c = a - B$$

and substituting these values in (14), this gives:

$$E = a\ \alpha + C\ \beta + a\ \beta + a\ \gamma - B\ \gamma$$

$$E = a\ (\alpha + \beta + \gamma) + C\ \beta - B\ \gamma$$

$$E = C\ \beta - B\ \gamma$$

The same result can also be obtained by substituting in the previous equation (13)

$$A = -(C + B)$$

$$\alpha = -(\beta + \gamma)$$

which are but other expressions of the second and third conditions, this gives

$$2\ E = (C + B)\ (\beta - \gamma) + (C - B)\ (\beta + \gamma)$$

$$= C\beta + B\beta + C\beta + C\gamma - B\gamma - C\gamma - B\beta - B\gamma$$

$$2\ E = 2\ C\beta - 2\ B\gamma$$

We see thus that the measurement of energy in the three phase system, which is likely to be the only one to come into extensive use, can be effected by one single reading of an instrument almost as simple as those used for the same purpose on ordinary alternating circuits.

The result is perfectly accurate and independent of whatever the currents and their phases may be and of however much these may differ from the phases of the electromotive forces.

For that reason the same instruments can be applied to the measurement of energy in the unsymmetrical four phase, with three conductors (Fig. 5), which may be considered as a special case of the general three phase system.

* *Elektrotechnische Zeitschrift*, 1892, p. 193.

Chronological History of Electricity—Part II.—1800-1820.

BY P. F. MOTTELAY.

HILDREN (John George), an English scientist to whom reference has already been made, more particularly under Cruikshanks, A.D. 1800, communicates to the *Phil. Trans.* "An account of some experiments performed with a view to ascertain the most advantageous method of constructing a voltaic apparatus for the purposes of chemical research." This paper appears also in vol. xxxiv. of the *Philosophical Magazine*.

Four years later (1813) he publishes a description of his magnificent galvanic battery, the largest ever constructed on the plan suggested by Dr. Wollaston, consisting of twenty pairs of copper and zinc plates, each six feet long and two feet eight inches wide, the united capacities of the cells being 945 gallons. With this battery he readily confirmed Davy's observations that "intensity increases with the number (of plates), and the quantity of electricity with the extent of the surface." When in full action the battery rendered a platinum wire 5 feet 6 inches long and $\frac{11}{100}$ths of an inch in diameter, red hot throughout so as to be visible in full daylight, while 8 feet 6 inches of platinum wire $\frac{44}{100}$ths of an inch in diameter was easily heated red. A bar of platinum $\frac{1}{8}$ of an inch square and $2\frac{1}{4}$ inches long was heated red hot and fused at the end; a round bar of the same metal $\frac{276}{1000}$ths of an inch in diameter and $2\frac{1}{2}$ inches long being heated bright red throughout.

Other experiments which he also made in 1813 and 1815, showed that metallic wires (eight inches long and $\frac{1}{30}$ of an inch diameter) became red hot in the following order: platinum, iron, copper, gold, zinc, silver; and he deduced that their conducting power was in the inverse order, silver conducting best and platinum least. Tin and lead fused so immediately at the point of contact, that no conclusion could be drawn respecting them. The oxides of tungsten, uranium, cerium, titanium, iridium and molybdenium were fused. An opening made with a saw across an iron wire having been filled with diamond powder, the diamond was liquified and the contiguous iron became steel.[1]

A. D. 1809-1810.—Oken (Lorenz)—originally Lorenz Ockenfuss—celebrated German naturalist, while occupying the post of Extraordinary Professor of Medicine at the University of Jena, publishes the great work "Lehrbuch der Naturphilosophie," which was translated into English by Dr. A. Tulk, and published in London, during 1847, by the Royal Society under the title of "Elements of Physico-philosophy."

This work, says his biographer in the "English Encyclopedia" (vol. vi., p. 557), takes the widest possible view of natural science. It is interesting as a document in the history of a great mental movement, and contains the germs of those principles which are now regarded as the secure generalization of well-observed facts.[2]

A. D. 1809.—Luc (Jean André de), celebrated natural philosopher of Swiss extraction, though, from 1773 until 1817, a resident of England, where he became reader to Queen Charlotte, the consort of George III., transmits to the Royal Society a long paper treating on the separation of the chemical from the electrical effects of the pile, with a description of the electric column and aërial electroscope.

In this communication, says Dr. Young, he advanced opinions so little in unison with the latest discoveries of the day, especially with those of the president of the Royal Society that the Council probably thought it would be either encouraging error or leading to controversy to admit them into the *Philosophical Transactions*. He had, indeed, on other occasions shown somewhat too much skepticism in the rejection of new facts, and he had never been convinced even of Mr. Cavendish's all-important discovery of the composition of water. The paper was afterwards published in *Nicholson's Journal* (vol. xxvi.), and the dry column described in it was constructed by various experimental philosophers. It exhibited a continual vibrating motion, which was made more sensible by the sound of a little bell, struck by the pendulum at each alternation; and the vibration

[1] See Pepys at A. D. 1802. For his other experiments, consult the *Phil. Mag.*, vols. xlii., p. 144; xlvi., pp. 409-415; *Phil. Trans.* for 1815, pp. 365-370, also Dr. William Henry's "Elem. of Exper. Chem.," London, 1823, vol. i., pp. 168-174; Dr. Thomas Thomson, "Outline of the Sciences," London, 1830, pp. 524-526; Louis Figuier, "Expo. et Hist.," Paris, 1857, vol. iv., pp. 389-390; Becquerel, vol. i., p. 52; "Encycl. Metrop.," vol. iv., pp. 179 and 222; Gmelin's Chemistry, vol. i. p. 424.

[2] Consult the extended biography of Lorenz Oken, embracing a list of his chief works and original essays, at pages 498-503, vol. xvi., of the Eighth "Encycl. Britannica," and Dr. William Whewell's "History of the Inductive Sciences," 1859, vol. ii., p. 477.

was more or less rapid, according to the state of the atmospherical electricity, and according to other circumstances affecting the column; but the motion ceased at last after a continuance of several months, or perhaps years.

This electric column consists of discs of Dutch gilt paper, alternated with similar discs of laminated zinc, so arranged that the order of succession will be maintained throughout. When sufficiently dry these are piled upon each other, the gilt side of the paper being in contact with the zinc, and pressed together in a glass tube by a brass cap and screw connected at each end with a metallic wire. The column which Mr. De Luc presented to the Royal Society consisted of 300 discs of zinc and of 300 discs of gilt paper. With a larger column, the vibration of a brass ball suspended between two bells was so continued as to maintain a perpetual ringing for over two years, while with an apparatus comprising 20,000 groups of silver, zinc and double discs of writing paper, sparks have been obtained, and a leaden jar was charged in ten minutes with sufficient electricity to produce shocks and to fuse an inch of platinum wire $\frac{1}{3000}$th of an inch in diameter. It is said that a similar pile in the Clarendon Laboratory at Oxford, rang ten small bells continuously for over forty years.

In volumes xxxv., xxxvi. and xxxvii. of the *Phil. Mag.*, and in volumes, xxvii. and xxviii. of *Nicholson's Journal*, Mr. De Luc shows how the dry column can be used for determining the insulating qualities and conducting power of bodies, it having been also employed as are aërial electroscopes to indicate the electrical changes taking place in the atmosphere. The other volumes of the same publications named below contain additional papers upon electricity, galvanism, etc., while at page 392, vol. l., of the *Phil. Mag.*, will be found an account of his life and of his principal works, the latter being likewise mentioned in vol. xxv., of the "Biographie Universelle."[3]

A. D.——Sömmering (Samuel Thomas von), German anatomist and physiologist, is the first to employ voltaic, or contact, electricity for the transmission of telegraphic signals.

Both his original and perfected working instruments were constructed between July 9 and Aug. 6, 1809.[4] The complete apparatus consists of 35 gold rods placed into glass tubes starting from a reservoir of acidulated water and connecting with 35 silk covered wires, which are run into 35 apertures of copper (corresponding with 25 letters and 10 figures) upon a wooden stand into each opening of which the wires of the voltaic pile can be inserted. When the latter are connected, the bubbles rising through the decomposition of the water are made to enter the lettered glass receivers through which the messages can be deciphered. On Aug. 8, 1809, he was enabled to transmit messages a distance of 1,000 feet, and 20 days later he presented his apparatus to the Bavarian Academy of Sciences.[5]

Sömmering's telegraph was carried by Dominique Jean Larrey, chief surgeon of the French armies, to Paris, where it was delivered by him to the French Academy of Sciences, Dec. 5, 1809, and Dr. Hamel states that Biot, Carnot, Charles and Monge were appointed by that body to report upon the new invention.[6] No report appears, however, to have been made. In 1810 and 1811, Sommering brought about several modifications to the apparatus, reducing the number of wires to twenty-seven. These wires, which consisted of either brass or copper, were insulated first with a covering of gum lac and then with silk thread, after which they were united into a thread covered cable 1,000 feet in length, this cable being in turn covered with heated gum lac or with a ribbon plunged in a solution of the same substance. For calling attention at the receiving instrument he would liberate an alarm by means of accumulated gas. The Russian Count Jeroslas Potocki took the new instrument to Vienna and submitted it July 1, 1811, to the Emperor Francis I., while another model of the apparatus was sent to William Sömmering, then at Geneva, where it was shown to De la Rive, Auguste Pictet and other scientists. During March, 1812, this simplified apparatus carried intelligence 10,000 feet, or ten times the distance previously reached.[7]

[3] See B. M. Forster, "Description . . elec. col. . . De Luc. . . ." London, 1810; *Phil. Mag.*, vol. xxxvii., p. 197; J. D. Maycock, *Phil. Mag.*, vol. xlviii., pp. 165, 255; L. Configliachi, "Osservazioni sulle pile a secco;" M. Delezenne, "Expériences sur les piles sèches;" *Bibl. Brit. Sci. et Arts*, vol. xlvii., p. 213; Gmelin's "Chemistry," vol. i., pp. 424-427; G. J. Singer's "Elements of Electricity" and William Sturgeon's *Annals of Electricity, passim*, as well as his "Researches," Bury, 1850, pp. 147, 199, 261; De La Rive's "Treatise on Electricity," vol. ii., p. 852; *Annales de Chimie et de Physique*, vol. ii., pp. 79-82 for May, 1816; Gilbert's *Annalen*, vol. xlix., also, vols. vii., 1801 to vol. lxxiv., 1821, for various articles upon the dry pile, etc.; G. Schübler, "Uber De Luc's Elektr. saule . . . " 1813; Geo. Wilson's "Life of Cavendish," London, 1851, p. 66, etc.; *Nicholson's Journal*, vols. xxi., xxii., xxxii., xxxiii., xxxv.; *Phil Mag.*, vols. xlii., xlv., the last named containing, at pages 359-363, Mr. G. J. Singer's paper on "the electric column considered as . . . first mover for mechanical purposes," while, at pages 466, 467 is the communication of Mr. Francis Ronalds on De Luc's electric column. The latter is also specially referred to in vol. xlii., pp. 241, 363; xlvi., p. 11; xlvii., pp. 47, 48; xlviii., pp. 165, 255; lvii., pp. 446, 447, and at page 55 of vol. xlix., is a paper relative to a "combination of the electric column, the thermometer, barometer and hygrometer in one instrument, for electro-atmospherical researches."

[4] *Journal Franklin Institute*, 1859, vols. xxxvii. and xxxviii.; *Journal Society of Arts*, vol. vii., p. 235.

[5] Fahie, "Hist. of Electric Telegraphy," p. 228.

[6] *Journal of the Franklin Institute* for 1859, vol. xxxviii., p. 398.

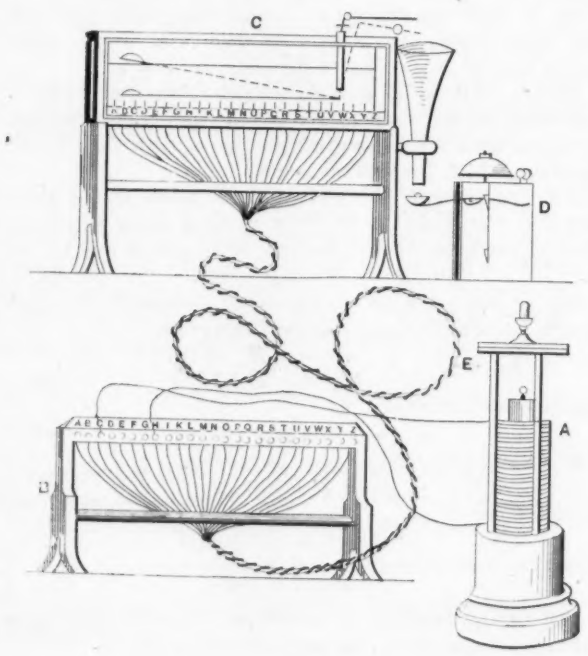
[7] Dr. Hamel, Cooke's reprint, pp. 7, 8. See Sömmering's own description of this, the first electro-chemical telegraph, in "Der Elektrische, etc.," published by his son William at Frankfort, 1863, or the translations at page 751 of Noad's "Manual," London, 1859, and at pages 230-234 of Fahie's "Hist. of Elec. Tel.," London, 1884; Dr. Hamel, in *Jour. Soc. of Arts*, for 1859, p. 453, or the reprint of W. F. Cooke in 1859, vol. vii., pp. 595-599 and 605-610; Du Moncel, "Exposé, etc.," vol. iii.; *Comptes Rendus*, tome vii., for 1838, p. 81; "De Bow's Review," vol. xxv., p. 551; Highton's "Elec. Tel.," p. 39; Harris', "Galvanism," p. 35; Sturgeon's *Ann. of Elec.*, vol. iii., March, 1839, pp. 447-448; Hibbard, Kv. 31, a; Gould, 68, a; "Denkschr. Münch. Akad. . . ," for 1809 and 1810, alluding to his first experimental instruments made in 1807; Schweigger, *Journal*, ii., pp. 217, 240 of vol. xx., for 1817; Poggendorff's *Annalen*, vol. cvii., pp. 614-647; "Smithsonian Report" for 1878, pp. 269-271; *Journal of the Franklin Institute* for 1851, vol. xxi., pp. 330-332; Prime's "Life of . . rof. Morse," 1875, pp. 263-275.

A. D. 1810.——Prechtl (Johann Joseph), German mathematician and chemist, director of the School of Arts and Navigation in Trieste, and professor in the Vienna Polytechnic Institute, is the author of several very interesting articles on electricity, magnetism, etc., which appeared in Gilbert's *Ann. der Physik* from vol. xxxv., for 1810, to vol. lxviii., for 1821, as well as in Gehlen's *Jour. für Chemie, Physic und Mineralogie*, vols. v. to vii. According to Figuier[8] we owe to Professor Prechtl a still more lucid explanation of the theory of electric distribution and equilibrium in the voltaic pile than was conveyed even by the learned Professor Jäger (A. D. 1802).

Of the many separate treatises which he wrote up to 1830, and which are contained in the numerous publications cited below, the most important, by far, is doubtless that treating of the fundamental state of the magnetic phenomena of the electrical connecting wire and on the transverse electrical charge (Uber d. transversalmagnetismus . . . ") which is to be found in Schweigger's *Journal für Chemie und Physik*, vol. xxxvi., pp. 390-410, and in Dr. Thomas Thomson's *Annals of Philosophy*, N. S., vol iv., pp. 1-6, for July, 1822. Alluding to the last named, Mr. Sturgeon says[9] that an *attempt* is made by Mr. Prechtl to explain the manner in which the connecting wire acts upon the needle, but that his diagrams and his mode of reasoning are too complex to be entered into the "Researches."[10]

A. D. 1810.——The compiler of this "Chronological History" will doubtless be pardoned for introducing here an additional mode of "communicating intelligence" promptly at great distances. Reference is made to the first germ of pneumatic telegraphy shown by the English engineer, Mr. George Medhurst, during the year 1810.

The London *Telegraphic Journal*, which gives an extract from the specification of Mr. Medhurst's patent "for a new method of conveying letters and goods with great certainty and rapidity by air," states that the process took practical form only in 1854, when Mr. Latimer Clark laid down a 1½-inch lead pipe between the Electric Telegraph Company's central station, Lothbury, and the London Stock Exchange. The system was extended in 1858 to Mincing Lane, and, two years later, Mr. Varley introduced the use of compressed air, so that messages were drawn one way by a vacuum, and propelled in the opposite direction by a plenum, instead of employing a vacuum both ways, as Mr. Clark had previously done. During the year 1865 the system, considerably modified, was introduced into Paris, and was also made use of, at about the same time, by the Messrs. Siemens, who employed it between the Bourse and the telegraph station in the city of Berlin.



Sommering's Telegraph.

A. D. 1810.——Jacopi (Joseph), Italian physician, anatomist and physiologist (1774-1813), pupil of the famous Scarpa, makes known through his "Elementi di Fisiologia e Notomia comparata" ("Elements de Physiologie et d'Anatomie comparée"), the results of his extended investigations of the electrical organs of the *torpedo*.

To him is due the first clear description of the electrical lobes situated in the *torpedo's* brain and of its relation to the eighth pair of nerves distributed throughout the hexagonal columns, which latter received also from him a very extended notice in the above-named work. The fifth ramification of nerves was first observed by Carus, and the most important investigation relative to the fourth and last important group of nerves directly connected with the electrical organs was made by the celebrated Italian professor Carlo Matteucci.[11]

[8] "Expos. et Hist. . . . " 1857, vol. iv., p. 433.

[9] "Scientific Researches," Bury, 1850, p. 29.

[10] See Poggendorff's "Biograph.-Liter. . . " vol. ii., pp. 519, 520; Larousse, "Dict. Univ." vol. xiii., p. 45; "Catal. Sc. Papers Roy. Soc." vol. v., p. 3-5; Gehlen's *Journal*, vols. vii., pp. 141-282, viii., pp. 297-318; Gilbert's *Annalen*, vols. xxxv., 1810, pp. 28-104, xliv., 1813, pp. 108-111, lxvii., 1821, pp. 81-108, 221, 222, 259-276, lxviii., 1821, pp. 104-106, 187-206, lxxvi., 1824, pp. 217-228; Brugnatelli's "Giornale," vol. iii., 1810, pp. 477-486; Kastner, "Archiv. Natur." ii., 1824, pp. 151-167; Wien, "Jahrb. Pol. Inst." vol. xiv., 1829, pp. 144-160, and Poggendorff's *Annalen der Physik und Chemie*, vol. xv., 1829, pp. 225-238.

[11] See Geoffroy St. Hilaire at A. D. 1803.

A. D. 1811.——Poisson (Siméon Denis), a very able French scientist, communicates to the "Institut des Mathématiques et Physiques" and publishes at Paris under the caption "Traité de Mécanique," his analytical observations of the electric phenomena which, it has been truly said, actually establish a new branch of, and is the best elementary work extant upon, mathematical physics. One of his biographers remarks that Poisson's object was "to leave no branch of physics unexplored by aid of the new and powerful methods of investigation which a school, yet more modern than that of Lagrange and Laplace, had added to the pure mathematics."

As shown, notably by Sir David Brewster in his able article on Electricity in the eighth "Encycl. Brit." (vol. viii., p. 531), and by Noad, in his "Manuel" (London, 1859, p. 15, 16)—

> Poisson adopted as the basis of his investigations the theory of two fluids, proposed by Symmer and Dufaye, with such modifications and additions as were suggested by the researches of Coulomb. He deduced theorems for determining the distribution of the electric fluid on the surfaces of two conducting spheres, when they are placed in contact or at any given distance, the truth of which had been established experimentally by Coulomb before the theorems themselves had been investigated. On bodies of elongated forms, or those which have edges, corners or points, it is shown as a consequence of the theory of two fluids that the electric fluid accumulates in greater depths about the edges, corners or points than in other places. Its expansive force, being therefore greater at such parts than elsewhere, exceeds the atmospheric pressure and escapes, while at other points of the surface it is retained.

In the latter connection Mary Somerville remarks:

> There can hardly be a doubt but that all the phenomena of magnetism, like those of electricity, may be explained on the hypothesis of one ethereal fluid, which is condensed or redundant in the positive pole, and deficient in the negative; a theory that accords best with the simplicity and general nature of the laws of creation; nevertheless, Poisson has adopted the hypothesis of two extremely rare fluids, pervading all the particles of iron, and incapable of leaving them. Whether the particles of these fluids are coincident with the molecules of the iron, or that they only fill the interstices between them, is unknown and immaterial. But it is certain that the sum of all the magnetic molecules, added to the sum of all the space between them, whether occupied by matter or not, must be equal to the whole volume of the magnetic body. . . . Mr. Poisson has proved that the result of the action of all the magnetic elements of a magnetized body is a force equivalent to the action of a very thin stratum covering the whole surface of a body, and consisting of the two fluids—the austral and the boreal, occupying different parts of it; in other words; the attractions and repulsions externally exerted by a magnet are exactly the same as if they proceeded from a very thin stratum of each fluid occupying the surface only, both fluids being in equal quantities, and so distributed that their total action upon all the points in the interior of the body is equal to nothing. Since the resulting force is the difference of the two polarities, its intensity must be greatly inferior to that of either.[12]

The "Mémoires de l' Institut" for 1811 contain Poisson's very able papers showing the manner in which electricity is distributed on the surfaces of bodies of various figures and the thickness of the stratum of electricity existing in different parts of these bodies. Mrs. Somerville further observes:[13]

> Although the distribution of the electric fluid has employed the eminent analytical talents of M. Poisson and Mr. Ivory, and though many of their computed phenomena have been confirmed by observation, yet recent experiments show that the subject is still involved in much difficulty. Electricity is entirely confined to the surface of bodies; or, if it does penetrate their substance, the depth is inappreciable; so that the quantity bodies are capable of receiving does not follow the proportion of their bulk, but depends principally upon the form and extent of surface over which it is spread; thus the exterior may be positively or negatively electric, while the interior is in a state of perfect neutrality.[14]

In the treatment of the theories of magnetism, Brewster alludes again to the masterly investigation of Poisson who, says he, appears to have been "the first to conceive the idea of absolute magnetic measurement. In a short but luminous article at the end of the 'Connaissance des Temps' for 1828, he describes the method for obtaining the value of **H** in absolute measure." His first and second "Mémoire sur la Théorie du Magnétisme" appeared during 1824-1825, at pages 247, 488, vol. v., of the *Transactions* of the Paris Royal Academy, and were closely followed (vol. vi., p. 441) by his Memoir on the theory of Magnetism in motion. Translations of these will be found at pages 326-358, 373, vol. i., and pages 328-330, vol. v., of the *Edinb. Jour. of Sci.*, and at pp. 334, 335 of John Farrar's "Elem. of Mag and Electro-Mag.," all published during the year 1826.

Poisson's theoretical prediction of magne-crystallic action is thus alluded to by Dr. John Tyndall in his "Researches on Diamagnetism, etc.," London, 1870, pp. xiii, and 66, 67:

> In March, 1851, Prof., now Sir William Thomson, drew attention to an exceedingly remarkable instance of theoretic foresight on the part of Poisson, with reference to the possibility of magne-crystalic action.
>
> Poisson, says Sir William, in his mathematical theory of magnetic induction founded on the hypothesis of magnetic fluids, "moving within the infinitely small magnetic elements," of which he assumes magnetizable matter to be constituted, does not overlook the possibility of those magnetic elements being non-spherical and symmetrically arranged in crystalline matter, and he remarks that a finite spherical portion of such a substance would, when in the neighborhood of a magnet, act differently according to the different positions into which it might be turned with its centre tube fixed. But "such a circumstance not having yet been observed," he excludes the consideration of the structure which would lead to it from his researches, and confines himself in his theory of magnetic induction to the case of matter consisting either of spherical magnetic elements or of non-symmetrically disposed elements of any forms. Now, however, when a recent discovery of Plucker's has established the very circumstance, the observation of which was wanting to induce Poisson to enter upon a full treatment of the subject, the importance of working out a magnetical theory of magnetic induction is obvious.
>
> Sir William Thomson then proceeds to make the necessary "extension of Poisson's Mathematical Theory of Magnetic Induction," and he publishes a striking quotation from the "Mémoires de l'Institut," 1821-1822, Paris, 1820.[15]

[12] See J. C. Wilcke at A. D. 1757, "Conn. of the Phys. Sci.," 1846, Sec. xxx. pp., 308, 309.

[13] Sec. xxviii. of work already cited.

[14] Consult J. Farrar, "Elem. of Elec. Magn. and Electro-Magn.," 1826, pp. 50-56.

[15] See biography in "English Encycl.," vol. iv., p. 899; *Phil. Mag.* for 1851; Roy. Soc. Catal. of Sci. Papers, vol. iv., pp. 964-969; G. M. Racagni "Sopra una Memoria . . . ," 1839; Johnson's Encycl., 1878, vol. iii., p. 227; Eighth "Britannica," vol. xv., p. 98; Ninth "Brittanica," vol. xv., pp. 241, 249; *Ann. de Chimie* for Feb., 1824; "Le Globe," No. 87; Harris, "Magnetism," p. 131; Whewell "Hist. of the Inductive Sciences," 1859, vol. ii., pp. 43, 208, 209, 222, 223; Sir William Thomson's works, 1872; Thomas Thomson, "An outline, etc.," 1830, p. 351; *Mem. de l'Acad. des Sci.* for 1824-1826, 1838; *Soc. Philom.* for 1803, 1824-1826; Humboldt's "Cosmos," London, 1849, vol. i., pp. 104, 105, 130, 165-169; N. Bowditch, "Of a mistake which exists in the calculation of Mr. Poisson relative to the distribution of the electric matter upon the surfaces of two globes in vol. xii., of the "Mem. . . . Sc. Math. . . . de France": *Mem Amer. Acad.*, O. S., vol. iv., part 1, p. 307.

Some Anomalies in Dynamo Design.*

It is frequently stated that no one can design a dynamo who is not a trained engineer. If this be the case, dynamos must be in rather a backward state, for very few dynamos are nominally designed by engineers. On the other hand, an eminent and very successful dynamo maker has said that a "cow of average intelligence could design two bearings, and that is all the engineering there is in a dynamo." Probably the truth lies between these extremes. There is not much engineering construction in a dynamo, and in most cases the machine bears the name of this or that electrician, while all the engineering details are worked out by experienced draughtsmen, who get little or no credit for their work.

Some years ago the complaint was made that dynamos were mechanically bad. The armatures were mounted on wooden hubs, and the machines looked as if they had been made by an optician. Now we are going to the other extreme. In order to appear "a thoroughly mechanical piece of work," a dynamo is made with a ton or two of extra cast iron parts having stresses in pounds but made heavy enough to stand pulls of many tons. The most serious forces in a dynamo are the magnetic pulls of the fields on the armature or on one another, but these receive very little attention. Few dynamos are designed to take these pulls fairly, and their value in pounds or tons is very seldom worked out. The air space in many dynamos decreases visibly when the field is excited. Still these pulls are steady and not intermittent, so little harm is done, though badly designed machines have come to grief from this cause. It is now the proper thing to admire a large and clumsy dynamo, on the ground that it is "a good solid mechanical machine." At the recent Crystal Palace Exhibition, any machine that was big and imposing as a structure had an admiring crowd round it. No inquiries were made as to what its output was or what it cost. If it weighed 20 tons and gave 20 kilowatts all would be quite satisfied and delighted. A very small machine is not necessarily cheap to make or good to work, generally the reverse; but a machine that is too large for its output is also always bad and expensive The most common method of making a dynamo into a "good solid piece of engineering" is to develop its bed-plate to an abnormal extent. But the only important stresses in a dynamo are internal; the motion is steady, and the other forces in the machine are insignificant. It is, therefore, unnecessary to mount the machine on an extensive substructure of hollow cast iron work. Many modern dynamos look as if their designers thought they would bend unless carefully secured to good solid foundations of rock by means of ample castings capable of withstanding the enormous stresses derived, presumably, from the belts or ropes. The illusion is generally entirely spoilt by hoisting the whole thing on two little slides, so as to admit of tightening the belt. There are many odd sights in electric stations and installations, but few are stranger than a dynamo with a ponderous bed-plate mounted on foundation rails. If the machine is designed to be used on foundation rails, the bed plate might be omitted, and full provision made for the dynamo to rest on the foundation rails, but it should not look as if it were trying in vain to sit down upon a large area, but could not reach the ground. If a casting is needed to form the framework of the dynamo, it should be arranged as a frame, and not as a bed-plate, and it might be designed much in the same way as the entablature of a paddle-wheel engine.

Any good impression that might be made by the imposing amount of cast iron in a modern dynamo is sadly weakened by the eyebolt with which an electrical engineer always crowns his work. The eyebolt suggests that the dynamo may break down at any instant, and can be whisked off—if such an expression can be used without disrespect to the bed-plate—and replaced by another at a moment's notice. The electrician's eyebolt is almost unique. Cylinder covers, piston rods, and other parts of marine engines have eyebolts; but they are inserted and taken out by hand when the vessel comes into port. Engineers do not provide eyebolts in other cases. The boilers of a steamer, for instance, are dropped in without difficulty, and an engine maker does not send out, say, a hundred-horse stationary engine all in one piece with an eyebolt, so that it can be lifted like a dynamo or a lady's parcel. In spite of its odd appearance the eyebolt has some advantages. But the money spent in making it, and carefully polishing it all over—a most essential process it would seem—can hardly be saved in reduced cost of carriage, due to ease of lifting in those cases where sufficiently powerful cranes are in use.

Few dynamos appear as if complete drawings had been made before building. Apparently the drawing office gets out the frame of the machine and some other department winds on the wire. The erectors at last find that there are a number of connections to be made, and the appearance of the machine is spoiled by the addition of rods and bars of silk-taped copper straggling about in all directions. The terminal board is screwed on wherever there is room for it, having apparently been forgotten when the machine was designed. The windings, except in rare cases, are left exposed. Sometimes they are painted red. This is a survival of the days when opticians painted electrical apparatus with red sealing wax varnish. They ought, of course, to be covered in. In America they are sometimes roped, but rope is a bad conductor of heat. Besides, a dynamo has already so much paper, cotton, vulcanized fibre, string and other materials suggestive of postage-stamp edging and sealing-wax, that it is a pity to use rope when metal can be employed.

After a few years' work most dynamos are saturated with oil. This is due to the design of the bearings not being thoroughly worked out. The drawing office designs a bearing, and the machine is sold, and nothing more is heard of it until the insulation breaks down, and it comes back to be re-wound; but even then nothing is attributed to the bearings. This is one of those cases—common enough in engineering—of want of touch between the makers and users of machinery.

* From *Industries* (London).

Prof. Marie-Davy Describes the Reversibility of the Dynamo-Electric Machine in a French Patent of the Year 1854.*

BY A. M. TANNER.

The writer has already called attention in the *Electrical Review* to early published descriptions disclosing the reversibility of dynamo or magneto-electric machines. The experiments of Jacobi and Sinsted in the early fifties should be sufficient to show that Pacinotti cannot be considered as having invented more than the ring armature and mode of commutation subsequently reinvented by Gramme. This honor is sufficiently great, and Mr. F. L. Pope errs when, in recent articles in the *Electrical Review*, he attributes the discovery of the reversibility of the dynamo-electric machine to Pacinotti.

There is, however, another instance positively describing the reversibility of the dynamo-electric machine before the year 1858, which is the date assigned to Pacinotti. It is the French patent of Prof. Marie-Davy, of Montpellier, France, dated May 11, 1854. This patent relates to electromagnetic machines or motors of various forms, all possessing, however, fixed and movable rings of electromagnets. Obviously this is not the Pacinotti construction; but as the question of the construction of the machine has nothing to do with the broad feature of the discovery of the reversibility thereof, it is only necessary to give the following translation of a portion of the specification of the Marie-Davy patent in order that historical justice may be done and honor bestowed to whom *honor is due*.

TRANSLATION.

"By replacing the soft iron pieces in the fixed electromagnets with pieces of steel or hardened and magnetized cast-iron, and causing the soft iron cylinders to roll on these magnets, electric currents are produced in the copper wires which cover the magnets. The machine which, under the influence of an electric current furnished by a battery, was a motor applicable to industrial purposes, then became, on the contrary, under the influence of an exterior motor, a powerful, economical, and eminently industrial source of electricity."

* From the *Electrical Review* (London).

The Age-Coating in Incandescent Lamps.†

BY PROF. EDWARD L. NICHOLS.

When an incandescent lamp is maintained at constant voltage it invariably falls off in candle-power. The diminution in brightness is attended by an increase in the amount of energy consumed per candle-power of light, this change being specially marked in the earlier portion of the life of the lamp. This phenomenon, which seems to take place in all incandescent lamps of the present day, was first studied exhaustively by Mr. W. H. Peirce, who read a paper entitled "The Relation Between the Initial and Average Efficiency of Incandescent Electric Lamps," before the American Institute of Electrical Engineers in 1889.‡ Mr. Peirce made a careful study of 94 lamps, including nearly all the types of glow-lamp then in use. He found no exception to the rule of progressive degeneration.§

These changes may be ascribed to at least three causes; loss of vacuum; increase of resistance, due to the disintegration of the filament; and, finally, the deposition of the disintegrated carbon upon the inner surface of the lamp-bulb. It was the object of the experiments to be described in this paper to make a study of this coating. We endeavored (1) to determine its character—that is to say, whether it is colorless or is selective in the particular rays it absorbs; (2) to learn something about the rate and distribution of deposit; and (3) to determine how far the absorption of light by the coating is accountable for the diminution in the brilliancy of the lamp.

For the determinations under the first head we made use of a form of polarizing spectro-photometer, which has been more than once described.‖ The standards of light were incandescent lamps. These were maintained at a candle-power considerably below the normal, that the changes taking place in them might be slow. Frequent comparisons of their spectra showed that the relative changes of brightness and quality of light were inappreciable. The first step in our investigation consisted in the measurement of the absorption spectra of the bulbs of certain unused lamps which had been selected for study. These lamps were then brought to degrees of incandescence, previously agreed upon, and were maintained in that condition by means of the current from a storage battery carefully kept constant, until they showed coatings of sufficient density to admit of ready measurement. They were then taken out of circuit and the absorption spectra of the blackened bulbs were determined. These readings gave the amount of light of each wave-length absorbed, and, by repetition, the rate of deposition during different periods of the lamp's existence. The entire set of photometric observations were duplicated, but since the final results obtained by the two independent observers (Moore and Ling) were in agreement, only the mean of the two sets is given in the following tables.

In order to ascertain precisely what part in the decadence of the lamp is attributed to the coating, it was necessary to keep careful watch of the continually shifting electrical and photometric conditions during its entire life; and in order to maintain in each lamp the precise conditions under which it had been determined that it should be burned, measurements of candle power and voltage had to be made at short intervals, together with continual readjustments of the current. Fourteen lamps in all were selected for the investigation. These were of two widely different types, represented the two great classes, viz., lamps with untreated and treated filaments. Of these, some were maintained at the voltage indicated by the maker, or at predetermined constant voltages other than this Others were kept at constant candle-power throughout their entire life, the current being increased whenever the decrease in brightness due to increasing age had become appreciable. From the data obtained in this way, the life curves of the various lamps were plotted, showing the variation in candle-power or voltage respectively, of resistance or efficiency expressed in watts per candle, during its entire existence. Some of these curves have already been published.* As these results were quite in accordance with those obtained by Mr. Peirce, to which reference has already been made, it will be necessary to deal with them only in so far as they bear upon the question of the influence of the age-coating upon the efficiency of the lamp.

COLOR OF THE COATING.

Measurements upon all 14 of the lamps which were subjected to the spectro photometric tests, showed the color of the coatings upon lamp-bulbs containing treated and untreated carbons respectively to be practically identical in character. The color of the coatings obtained in lamps of either type, under widely diverse conditions (as, for example, by manintaining a 16 c p. lamp at 64 candles throughout its life), was the same as that produced under normal conditions of service. The color in question is very nearly neutral, the percentage of light transmitted being approximately the same for all parts of the visible spectrum. The effect of the "*age coating*," as the deposit which we are considering may be called, is therefore to dim the lamp, without appreciably changing the quality of its light.

The most complete set of observations obtained with lamps of untreated carbon are those referring to a lamp designated in our list as No. 2.† This lamp was maintained at normal voltage for over 800 hours. Frequent readings of candle-power and current during this time afforded the means of tracing the progressive changes of light-giving power, efficiency and resistance. Measurements of the age-coating were made after 100, 200, 400, and 800 hours of life, readings being taken in ten regions of the spectrum. The results are given in Table I., together with data indicating the condition of the lamp at the above mentioned periods of life. These are taken from a set of 67 readings of voltage and current, distributed over the entire life of the lamp at nearly equal intervals. The variation in voltage during the entire 800 hours was never more than 0.3 volt above or below the initial value.

Another typical case was that of lamp No. 10, which was a lamp with a treated filament. It was maintained at a very different degree of incandescence, being a lamp of low efficiency, which, when set at the voltage indicated by the manufacturer, required an expenditure of 5.16 watts per candle. The age coating of this lamp approached even more nearly to complete neutrality of shade than did most of those which we had occasion to measure. The results obtained at 200 and 900 hours are given in Table II.

The normal life of a lamp starting at 5 watts per candle is many thousands of hours. Lamp No. 10 was prematurely broken at 908 hours, at which time the coating had reached a density corresponding to that of a 3-watt lamp (No. 2) ofter 200 hours of life. A comparison of Tables I. and II. will show that while the coatings on these two lamp bulbs were not quite neutral nor precisely identical in tint, that they both transmit light with much greater uniformity than do such materials, for example, as optical glass, calcite, etc.‡

† From the *American Journal of Science*, vol. xliv., October, 1892. Experimental work by Messrs. B. E. Moore and C. J. Ling. Contribution from the Physical Laboratory of Cornell University.

‡ THE ELECTRICAL WORLD, June 8, 1889.

§ Since the above was written an extended investigation upon this subject has appeared. It entirely confirms the results obtained. See "A Life and Efficiency Test of Incandescent Lamps," by Prof. B. F. Thomas and Messrs. Martin and Hasler, THE ELECTRICAL WORLD, July 16, 1892.

‖ *Phil. Mag.*, xxxii., p. 404, November, 1891.

* "The Artificial Light of the Future."—THE ELECTRICAL WORLD, Nov. 29, 1890.

† This and other numbers used refer to the records of these experiments as given in full in the thesis of Messrs. Moore and Ling, a manuscript deposited in the Library of Cornell University. ("The Life and Duration of Incandescent Lamps, with Special Reference to the Light Absorbed by the Coating Within the Bulb." By B. E. Moore and C. J. Ling. 1890.)

‡ See Kruess, Kolorimetrie, p. 243; also, Nichols and Snow, *Phil. Mag.*, vol. xxxiii., p. 379, April, 1892.

TABLE I.—LAMP NO. 2 (UNTREATED FILAMENT.)
INITIAL CONDITIONS.

Volts.	Ampère.	Ohms.	Candle-power.	Watts per candle.
101 8	0.474	214.8	16.00	3.015

CONDITIONS AFTER 100 HOURS.

Volts.	Ampère.	Ohms.	Candle-power.	Watts per candle.
101.9	0.463	225.3	12.50	3.697

LIGHT TRANSMITTED BY THE COATING, AFTER 100 HOURS.

λ=0.750	88.9 per cent.	λ=0.507	92.2 per cent.
0 713	89.2 " "	0.481	92.8 " "
0 635	91.8 " "	0.460	92.3 " "
0.588	91.5 " "	0.443	92.4 " "
0.538	91.9 " "	0 429	92.4 " "

CONDITIONS AFTER 200 HOURS.

Volts.	Ampère.	Ohms.	Candle power.	Watts per candle.
101.8	0.421	275 9	10.3	4.250

LIGHT TRANSMITTED BY THE COATING AFTER 200 HOURS.

λ = 0.750	83.5 per cent.	λ = 0.507	86.4 per cent.
0.713	84.5 "	0.481	86.9 "
0.635	85.6 "	0.460	87.6 "
0.580	85.4 "	0 443	87.9 "
0.538	85.9 "	0.429	85.4 "

CONDITIONS AFTER 400 HOURS.

Volts.	Ampère.	Ohms.	Candle-power.	Watts per candle.
101.8	0.428	247 7	9.67	4.510

LIGHT TRANSMITTED BY THE COATING AFTER 400 HOURS.

λ = 0.750	79 3 per cent.	λ = 0.507	83.5 per cent.
0.713	80.9 " "	0.481	83.6 " "
0.635	82.3 " "	0.460	84.0 " "
0 583	82.0 " "	0.443	84.3 " "
0.538	82.6 " "	0.429	82.1 " "

CONDITIONS AFTER 800 HOURS.

Volts.	Ampère.	Ohms.	Candle-power.	Watts per candle.
101.9	0 415	245.6	7.20	5 880

LIGHT TRANSMITTED BY THE COATING AFTER 800 HOURS.

λ = 0.750	75.7 per cent.	λ = 0.507	78.7 per cent.
0.713	75.9 " "	0.481	79.4 " "
0 635	78.0 " "	0.460	79.9 " "
0 580	78.6 " "	0.443	80.5 " "
0.538	78.4 " "	0.429	77.3 " "

TABLE II.—LAMP NO. 10 (TREATED FILAMENT).
INITIAL CONDITIONS.

Volts.	Ampères.	Ohms.	Candle power.	Watts per candle.
31.0	1.171	30.63	8.2	5.16

CONDITIONS AFTER 200 HOURS.

Volts.	Ampères.	Ohms.	Candle-power.	Watts per candle.
35.9	1.145	31.27	7.1	5.91

LIGHT TRANSMITTED BY THE COATING AFTER 200 HOURS.

=0.750	91 9 per cent.	λ= 0.507	90.7 per cent.
0.713	90.4 " "	0.481	91.4 " "
0.635	89.5 " "	0.460	90.7 " "
0.580	90.5 " "	0.443	90.5 " "
0 538	90.5 " "	0.429	90.4 " "

CONDITIONS AFTER 908 HOURS.

Volts.	Ampéres.	Ohms.	Candle-power.	Watts per candle.
36.14	1.11	31.70	(unknown)*	

*The lamp was broken before the photometric measurements had been completed.

LIGHT TRANSMITTED BY THE COATING AFTER 908 HOURS.

λ=0.750	86.6 per cent.	λ=0.507	84.5 per cent.
0.713	85.2 "	0.481	85.0 "
0.635	83.1 "	0 460	85.5 "
0.580	83.6 "	0.443	86.0 "
0 538	84.5 "	0.429	86.0 "

THE DISTRIBUTION OF THE AGE-COATING WITHIN THE BULB.

The distribution of the age coating was determined indirectly as follows: Two of the lamps under examination were measured for horizontal candle-power, according to the Franklin Institute method;* measurements being made in 12 meridians, 30 degrees apart. The readings were repeated at frequent intervals throughout the life of the lamps. The results were plotted with polar co-ordinates. They show (Fig. 1) by the diminishing area of the successive curves the progressive loss of brightness due to age, of which about one-half is ascribable to the coating. The similarity of the curves, from first to last, indicates that the coating is deposited uniformly within the bulb, or in uniform lateral zones, so that the density of the film is symmetrical with reference to any given meridian. The case chosen for illustration is lamp No. 7. The results obtained with lamp No. 8 were in every essential respect the same as those shown in the diagram.

* See Franklin Institute Tests (International Electrical Exhibition, 1884), Philadelphia, 1885.

THE AGE-COATING CONSIDERED AS A FACTOR IN THE DIMINISHING EFFICIENCY OF THE LAMP.

It may be seen from the tables (I. and II.) that the absorbing power of the coating is in itself sufficient to account for a very considerable falling off in the candle-power, as the lamp, within the bulb of which it forms, grows old in service. By summation of the values in the tables, we may obtain the average absorbing power for the entire spectrum; and since selective absorption is almost entirely absent, these averages will give very closely indeed the loss in candle-power, which at the time in question was ascribable

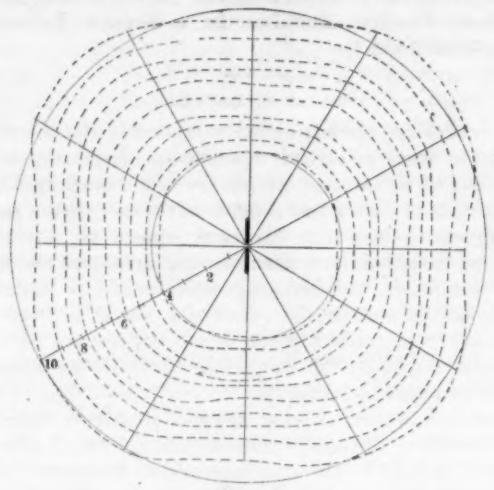


Fig. 1.

to the influence of the coating. From the data in Tables I. and II., also, we may compute the efficiencies of the lamps at various stages in terms of their initial efficiency as unity; likewise their brightness from time to time, in terms of their initial candle-power, as unity. In Tables III. and IV. are given, for purpose of comparison, the relative brightness and efficiency of lamps 2 to 10, at various periods, also the average absorbing power of their coating.

TABLE III.—RELATIVE BRIGHTNESS, EFFICIENCY, AND TRANSPARENCY OF LAMP NO. 2, AT VARIOUS PERIODS, (EACH EXPRESSED IN TERMS OF ITS INITIAL VALUE, TAKEN AS 100).

Time.	Relative brightness.	Relative efficiency.	Relative transparency of bulb.
000. hours	100.	100.	100.
100. "	78·1	81.5	91.44
200. "	67.5	70 9	85 91
400. "	60.4	66.8	82.46
800. "	45.0	51.3	78.24

TABLE IV.—RELATIVE BRIGHTNESS, EFFICIENCY, AND TRANSPARENCY OF LAMP 10, AT VARIOUS PERIODS (EACH EXPRESSED IN TERMS OF ITS INITIAL VALUE TAKEN AS 100).

Time.	Relative brightness.	Relative efficiency.	Relative transparency of bulb.
0. hours.	100.	100.	100.
50. "	92.6	92.6	—
109. "	91.4	90.1	—
200. "	86.5	87.3	90 5
400. "	80.5	81.6	—
511. "	78.7	80.0	—
600. "	78.0	79.5	—
900. "	—	—	85.0

The curves in Fig. 2 are based upon these data. They show that the loss in candle power and efficiency are only

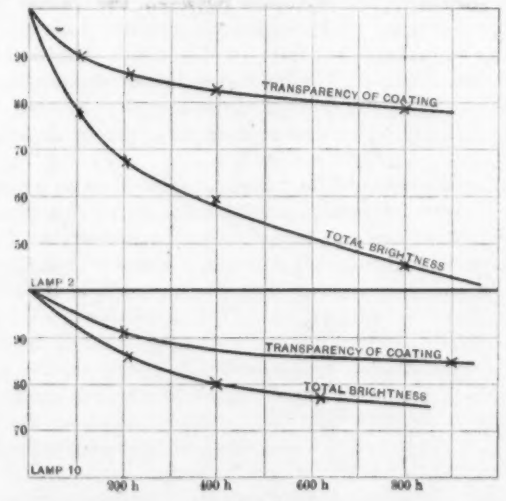


Fig. 2.

in part due to the opacity of the coatings. It is of some interest to compare lamps 2 and 10, since the former is a 3-watt lamp, whereas the other required 5.16 watts per candle at the beginning of the test. It is to be regretted that the tests did not extend over the normal lifetime of such a lamp; the results obtained, however, suffice to show that the loss due to coating is a much larger portion of the total loss in the low efficiency lamp than in the other. Measurements with several lamps, maintained at abnormally high temperatures, seemed to indicate that the higher the state of incandescence the less marked (relatively) is the influence of the age-coating upon the decadence of the lamp.

SUMMARY OF RESULTS.

1. The rate of deposit of the coating in incandescent lamp bulbs is greatest in the early part of the life of the lamp. For example, in the case of a lamp which lasted 800 hours (see Table III.) more than half of the coating was deposited during the first 200 hours.

2 The loss of brightness due to the absorbing power of the age-coating is a variable part of the total loss, being greatest in lamps of high initial efficiency.

3. The coating does not appreciably modify the character of the light which emanates from the lamp.

4. The distribution of the coating within the bulb is a nearly uniform one (see Fig. 1).

5. No marked difference between treated and untreated filaments appears to exist, as regards the density of quality of the coating produced from them.*

Development in Electric Metal Working.†

BY FREDERICK P. ROYCE.

[The first part of the paper is devoted to a description of Prof. Elihu Thomson's process of electric welding, and of the apparatus at present used. The author also gives some of the advantages of this method over the usual forging process. After a brief reference to welding by the use of the arc, he states:]

In the year 1888 the electric welding process was first practically applied to commercial work. Machines were rapidly built for various purposes, and welding plants were soon established in various large works throughout the country for a great variety of purposes.

Iron, steel, copper or brass wire of various sizes are united into long lengths; rods and bars of iron and steel are welded, shaped and forged by electrical heat; axles, tires, small parts of carriage and wagon work are turned out in large and rapidly increasing quantities; tubes of iron or steel are welded together in lengths of several hundred feet, and bent into spirals or oblong coils of sizes and shapes required; parts of bicycles are brazed or welded, as the case may be; iron agricultural wheels are welded spoke to hub and spoke upset to tire; fine grades of tool steel, as Mushet or Jessop's, are welded to machine steel, forming tool blanks, which may be used with great economy in all machine shops; lead composition plates are electrically connected for storage battery purposes; forgings of ten square inches of section are heated by the welding process, and united by enormous hydraulic pressure; ship stanchions, rods and shafting are easily welded by powerful machines in our different navy yards, and the field is rapidly broadening for a greater variety of work, and with most satisfactory results.

The newly developed methods of producing aluminium, and the consequent decrease in its cost, promises to open a wide field for this process, as the metal can be welded easily and as quickly as either steel or iron.

Special machines have necessarily been built adapted to the requirements of these different grades of work. The conditions are constantly changing and welders varying from 50 pounds weight to that of several tons are built as called for to meet the demands from various sources.

At the works of the Johnson Company, at Johnstown, Pa., several hundred large welds, in connection with their various forms of road bed construction, are made daily.

There 10 square inches of steel or iron are easily welded together, a pressure of 150 tons being supplied by heavy hydraulic appliances to reduce the burr or upset and finish the metal.

The complete welders are installed at their works, five of them for rail work alone, and weighing upward of 30 tons each.

The leading carriage and wagon manufacturers were the first in the field, and among those who then became interested in welding by electricity were Studebaker Bros. Manufacturing Company, of South Bend, Ind; Haydock Bros., of St. Louis, Mo.; the Parry Manufacturing Company, of Indianapolis, Ind., the Racine Wagon and Carriage Company, of Racine, Wis, and the Kentucky Wagon Manufacturing Company, of Louisville, Ky.

They investigated the process thoroughly, and electric welding machines are now in active and successful operation in their shops. The Cleveland Axle Manufacturing Company, of Cleveland, O., the Sheldon Axle Company, of Wilkes Barre, Pa., and the M. Seward & Son Company, of New Haven, Conn., were also among the first to instal apparatus.

Comparisons of Cost of Electric and Forge Welding.—Inquiries are constantly made as to the cost of electric welding in comparison with that of the older forge methods and it is to this important matter that it is desirable to give special attention in this paper.

There are two important elements that enter into the cost of welding: the labor required at the welder and the necessary power to drive the dynamo.

Regarding the labor, an engineer always employed in carriage and wagon factories can easily attend to the running of the dynamo. The machine is simple in its construction, it requires but very little care; it must be properly

* Since this article was written it has been pointed out by Prof B. F. Thomas (in the Paper already cited) that in the case of lamps exhausted without the aid of mercury, the age-coating is scarcely perceptible.

† Abstract of a paper read at the Buffalo Convention of the Chicago Builders' National Association.

oiled, the brushes and collector rings kept clean, but beyond that needs little or no attention.

One man only is needed to operate the welder, where the pieces to be united are of regular shape, and the weight is such that they can be easily handled. In case great rapidity of work is essential, an assistant, generally a boy, will be the only additional helper required to facilitate the handling of stock.

In the case of axle work, two men are generally needed, a blacksmith to do the welding and a helper in reducing the burr or upset under hammer and in setting the axle, turning out easily 150 sets of 1-inch axles, or 100 sets of 1½-inch axles, as the case may be.

In case of light iron buggy tires, one man can easily weld from 700 to 800 daily with a helper, at low wages, to bring the stock to the machine and take it away. In the case of steel tires, 400 or 500 can be similarly welded. In heavy wagon tires somewhat more help is needed. At the Studebaker Works two heavy tire welders are placed side by side, with a hammer conveniently located, and a force of five men turn out a large product daily.

The smaller parts of carriage and wagon work are easily managed by a single operator. Fifth wheels, step irons, carriage rails, dash irons and other similar classes of work are turned out with great rapidity.

The removal of the upset or burr at the point of welding is, of course an element of cost, and can be done in a variety of ways. Grinding was at first tried, but this was found to be too slow and expensive in connection with wagon work. Rolling was also attempted, but found to be impracticable commercially. Hammering has been found to be the cheapest and most effective method so far tried. All welds retain sufficient heat after they are removed from the welding machine to be hammered as much as may be required. Not only does the hammering reduce the burr to the size of the metal, but materially strengthens and improves the weld.

Various hammers have been designed working directly in connection with the welding machine, but with wagon and carriage work the ordinary light power hammer is found to be the most efficient. Either power or hydraulic presses have been found to be efficient in some varieties of work.

When welding apparatus was first introduced into carriage works, the cost of preparation of the parts to be welded was quite an item of expense. It was at that time thought best to remove all forms of oxide which might have accumulated on the steel or iron, but as this required both time and labor, it was speedily abandoned and it was decided to be more economical to increase somewhat the force of the current used for the welding, even at the expense of additional power required, and no preparation of the metal is now regarded necessary, as far as the ordinary oxide formed by the rolling of metal bars is concerned.

Should there be a heavy red oxide, or serious accumulation of foreign matter, it is best to remove this before the weld is made. It is frequently done by pickling, where large quantities of metal are to be cleaned cheaply, but it is only in exceptional cases where this is necessary.

The question of actual horse power required for welding both axles and tires has been carefully considered, and the following figures are based upon actual experience in various works and from very careful electrical and mechanical tests made by reliable experts:

1	inch	round	axle	requires	25	h. p. for	45 seconds.
1	"	square	"	"	30	"	48 "
1¼	"	round	"	"	35	"	60 "
1¼	"	square	"	"	40	"	70 "
2	"	r und	"	"	75	"	95 "
2	"	square	"	"	90	"	100 "

The slightly increased time and power required for welding the square axle is not only due to the extra metal in it but in part to the care which it is best to use to secure a perfect alignment.

TIRE WELDING.

1 inch	× 3/16	inch	tire	requires	11	h. p. for	15 seconds.
1¼ "	× ¾	"	"	"	23	"	25 "
1½ "	× ¼	"	"	"	20	"	30 "
1½ "	× ½	"	"	"	23	"	40 "
2 "	× ½	"	"	"	29	"	55 "
2 "	× ¾	"	"	"	42	"	62 "

The time above given for welding is, of course, that required for the actual application of the current only, and does not include that consumed by placing the axles or tires in the machine, the removal of the upset and other finishing processes.

From the data thus submitted the cost of welding can be readily figured for any locality where the price of fuel and cost of labor are known.

New Electrical Measuring Apparatus.

The study of applied electricity is now so universal that high schools as well as colleges devote considerable time to the subject. Apparatus adapted for research work is quite too costly for elementary instruction, and in consequence, until recently, many schools have not been able to treat this important branch as fully as was desirable. Instrument makers are appreciating the need for first-class elementary instruments, and in this issue we give a brief description of a few important pieces which are being placed on the market by Queen & Co., of Philadelphia. The different pieces have been designed in their laboratory and are constructed substantially, but without the same degree of finish which is placed on the finer apparatus which this firm makes.

Fig. 1 shows a D'Arsonval galvanometer intended to be placed against the wall of a laboratory. It has a graduated scale with pointer and also a mirror, so that readings may be taken directly or by means of a telescope or lamp and scale. This instrument is extremely dead beat, and is adapted for general work where quick measurements are desired.

A universal tangent galvanometer is represented in Fig. 2, which is especially designed for determining current in absolute measure, and for showing the effects of variation in the different quantities contained in the tangent galvanometer equation. It has two mahogany rings, built up of a number of pieces to prevent warping. One ring is wound so as to rotate freely on a vertical axis, with a pointer and scale graduated to degrees for use in sine measurements. The compass box slides along the horizontal graduated bar, so that the needle may be placed in the plane of either coil, as a tangent galvanometer; midway between them, as in a Helmholtz-Gaugain galvanometer, or at any point upon the axis outside the planes of both coils, as in the Weidemann type. The instrument can thus be used for a great variety of purposes.

The quadrant electrometer (Fig. 3) is intended for use by the beginner, and is of simple construction, while capable of a high degree of accuracy. The quadrants are fastened to a circular block of hard rubber, two of them being made of one piece of metal, bent so as to have a level surface on top, to which the brass suspension tube and one binding post are attached. The aluminium needle, provided with mirror for reading deflections, and vanes for damping the system are suspended from an adjustable torsion head, thus connecting it with one pair of quadrants. In this way the Leyden jar arrangement, otherwise necessary for maintaining the needle at a high potential is avoided. A metal case encloses the aparatus, leaving room inside for a small dish of sulphuric acid and pumice stone for drying purposes.

Fig. 4 represents a coulomb electrometer which differs from other types in that the suspension tube is free to rotate, and at the bottom carries a pointer which moves over a scale graduated on top of the glass case. A mirror is placed in the bottom of the case to avoid parallax.

A very convenient form of magnetometer is shown in Fig. 5, which will prove invaluable for laboratory work. The illustration is very clear, so that it is not necessary to give details of construction. Observations may be taken either directly by aid of pointer deflections or by the telescope and scale method, a mirror being attached to the magnet system. Results almost as accurate can be obtained with this apparatus as with the well-known "Kew" pattern, which is very much more expensive.

The earth inductor, Fig. 6, is arranged for exact measurements, and a certificate of constants is supplied as with more elaborate forms. The coil form is built in four sections to prevent warping, and the coil is wound in layers, the diameter of each being carefully determined.

Fig. 7 shows a voltameter suggested by Prof. Ryan, of Cornell University. It is of simple construction, and possesses important features, such as freedom of electrodes from angles and sharp corners, easy removal of the electrodes, facility for cleansing, and greater homogeneity of deposit. The electrodes may be lowered or raised to give corresponding changes of resistance.

Fig. 8 shows a Rumford dispersion photometer, similar to that described in Prof. Ayrton's "Practical Electricity." It has a range of measurement up to 1,000 candles.

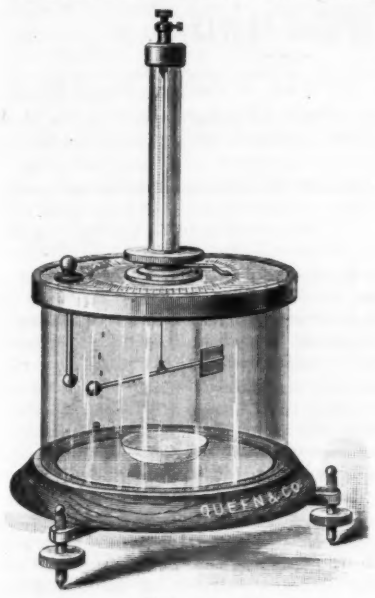


FIG. 4.

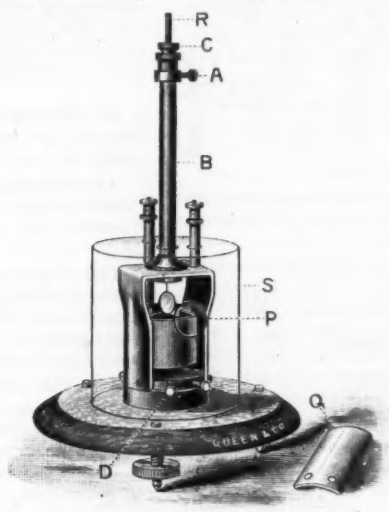


FIG. 3.

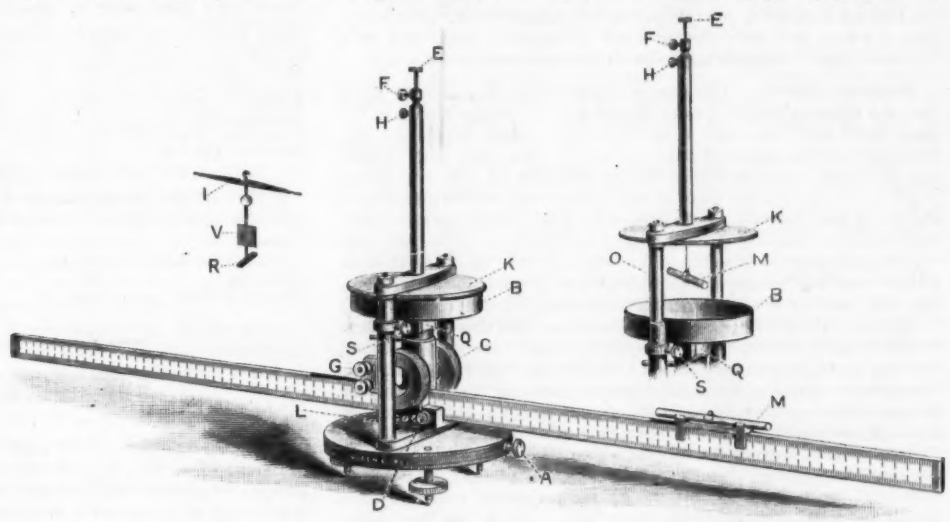


FIG. 5.

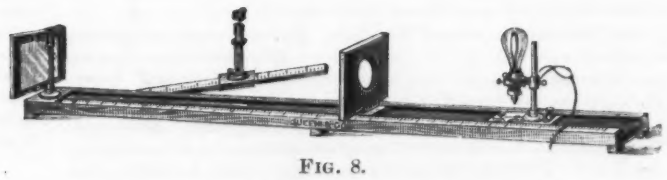


FIG. 8.

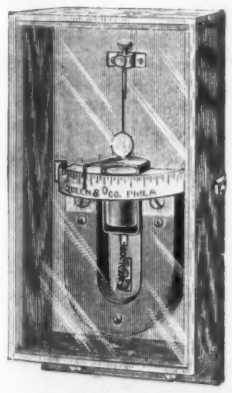


FIG. 1.

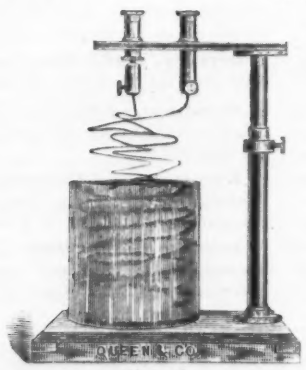


FIG. 7.

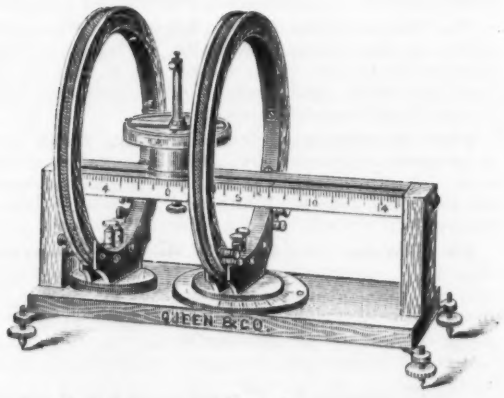


FIG. 2.

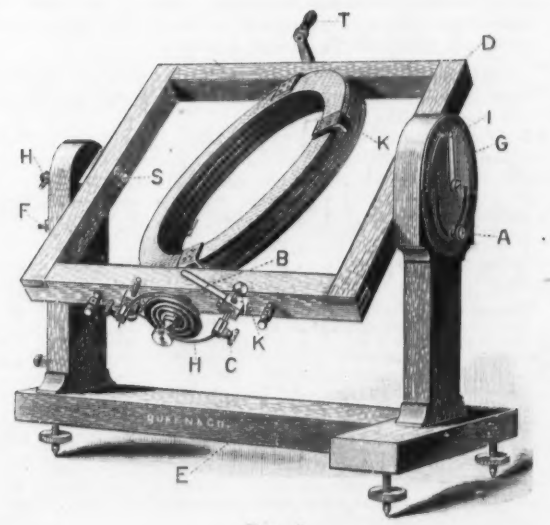


FIG. 6.

QUEEN & CO.'S NEW ELECTRICAL MEASURING INSTRUMENTS.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

[Inquiries from our patrons for information relative to stocks and bonds of the various electric light and power companies are solicited, and will be answered in this column.]

NEW YORK, Nov. 4, 1892.

New York General Financial Stock Market.—Wall Street is seldom active except on the strength of good news or in discount of some coming event. Where there is a contingency which promises to be a controlling condition and which cannot be discounted the Street relapses to a condition of apathy. This is the situation at the present time, pending the election of next week. It has checked the bull movement, causing prices to reign through a narrower margin. The course has been almost featureless and will probably continue so until the result of the election is known. The tone of the money market remains hard and rates firm. The grain blockade has caused an advance of money in Chicago. The state of trade throughout the country is reported good. Certain large operators are commencing to talk very bullish in regards to the World's Fair and prophecy enormous increases in value of the various securities.

NEW YORK ELECTRICAL STOCK MARKET.

In General.—The foregoing is applicable to this department of the market. The electrical stocks were about as active as those of the general list, and at fairly well sustained values. North American maintained its even pace at 12¼ to 12⅝. American Telegraph Cable did not differ in its courses as compared in the previous weeks at 86 and 87. Edison Electric Illuminating maintained its strength of last week on limited sales ranged between 106½ to 106¾. A small lot of its bonds sold at 108.

General Electric.—The stock showed a slightly declining tendency, owing to the indifference of speculative element toward transactions. The closing was at 15⅝ against an opening of 16½. Officers of the company say that they have moved for an injunction restraining the Sawyer-Mann company from manufacturing the incandescent lamps. They have already secured an injunction against the United States Electric Lamp Company. The policy of the General Electric Company with respect to competitors has not been outlined farther than a determination to compel them to vacate the field as ordered by the court. Questions of damage for infringement are considered secondary. The company's officers are not inclined to discuss the new Westinghouse lamp, owing to the limited data available relative to its construction. However, they say that it must differ in more particulars than that of a "glass stopper" in order not to be an infringement.

Western Union.—The closing was at 98½ to 98¾. There was a loss of a fraction for the week. There will be no movement in the stock until after the issue of a 10 per cent. script dividend. The directors met Tuesday and adjourned to a week from next Thursday without decisive action on the distribution of the new stock. A director says that the form in which the stock will be distributed cannot be announced yet because it will take some time to make the necessary preparations. He intimates that another legal step may be taken before the plan will be carried out. Another director tells us that final action on the distribution of the new stock cannot be taken until after the filing of a certificate of increase of capital at Albany. He thinks it probable, however, that there will be a 10 per cent. stock dividend to stockholders. A feature of interest in the last annual report of Western Union is the fact that this year the amount of Gold and Stock Telegraph Company's stock held by Western Union amounts to 14,438 shares against 23,727 shares as given in the report last year, a reduction of 8,289 shares, or $828,900. No explanation is given for this reduction. Officials of the company say that this amount of stock was deposited in a trust company and collateral trust five per cent. bonds for an equal amount were issued and sold. The proceeds have been used to lay two cables from the Gulf of Canso to New York. The stock pays six per cent., and the company by exchanging it has saved one per cent. in interest by the transaction.

Commercial Cable.—It will be remembered that a few weeks ago we prophesied that this stock would be without transactions for a couple of weeks and then score a material advance. This prediction has been verified. It sold at 170 on Wednesday against previous quotations of 164.

Closing Quotations.—The following were the closing quotations of electric stocks on Thursday, Nov. 4, 1892, and the range for the week in New York:

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Low-est.	High-est.	Bid.	Ask'd.
American District Tel....	100	3,825,000	59½	60	58½	59½
American Tel. & Cable..	100	14,000,000	86	87	85½	87½
Central & So. Am. Tel....	100	6,000,000	....	....	....	....
Commercial Cables.....	100	7,716,000	170	170	164	170
Gold Stock & Tel	100	5,000,000	..	....	100	103
Bonds.....	500	500,000	....	....	100	..
Postal Tel. & Cable.....	...	10,000,000	....	....	62	64
Southern & Atlantic Tel..	25	948,775	....	....	78	84
Western Union Tel.....	100	86,199,852	98¼	99½	98⅝	98¾
Real estate bonds.....1,000		1,219,000	....	....	....	..
Debenture bonds. 1,000		4,920,000	..	..	..	....
Collateral Trust 5's....1,000		8,181,000	103¼	104	....	....
North American.....	100	39,767,200	12¼	12⅝	13	13¾
Brush Ill. Co. of N. Y.....	50	1,000,000	....	....	39	60
Edison El. Il. of N. Y.....	100	6,500,000	106½	106½	105½	107
" " 1sts.....	...	.....	108	108	...	...
" " Deb's...	...	.....	....	....	...	....
Edison El. Il. of Brooklyn.	100	750,000	...	....	85	90
" " " " Chicago..	100	750,000	....	....	130	145
" " " " Boston...	...	.....	....	....	115	125
Edison El. Lt. Europe....1,000		2,000,000	....	....	2	6
" Bonds.....		30,000	....	....	65	80
Edison Ore Milling Co.....	...	2,000,000	....	....	15	20
East River El. Light.....	100	1,000,000	....	....	...	65
General Electric	1,000	50,000,000	115½	116⅛	....	116
Debenture 5's	....	.....	105¾	105¾	....	....
Automatic Exhibition Co. ...		2,500,000	..	....	3	5
Mt. Morris Electric.....	...	500,000	....	....	....	65
N. E. Phonograph.....	...	2,000,000	....	....	2	4
N. Y. Phonograph	...	2,000,000	....	....	2	5
N. American Phonograph ..		2,000,000	....	....	4	6
Westinghouse E & M. Co. 1st p. 7 per cent. Cum.	50	3,717,253	....	....		....
E. & M. Co. Assg.....	50	5,038,116	....	....	....	....

BOSTON, Nov. 3, 1892.

The General Market.—As might naturally be expected at a time so near the date of election, when both sides are crowded with doubts and uncertainties as to the result, the interest in the stock market has been at a low mark, and all conditions have been decidedly dull and uninviting. It is suggested that there is more money used this week in covering bets on the election than in covering margins on stocks. On Monday the market opened with every evidence of good strength and activity, but these conditions were of short duration, and very soon again sales became few and far between. With the lack of interest and activity prices began to weaken, and quotations show a decline in nearly all the prominent stocks. There is no great amount of liquidation, and that the market does not go lower speaks well for the faith of operators that an active upward movement will follow Tuesday's election Bay State Gas is an interesting factor in this market, but during the past week its quietness has led to low prices. Copper stocks have been more active than usually, but like the rest of the list they are lower than before. Numerous reports concerning Boston & Montana copper stock have brought out its real situation, and under good market conditions it will regain more points than it has recently lost.

General Electric Stock shows a slight gain for the week. Sales have been few, but at prices practically unchanged, and displaying excellent strength and support in the face of this weak and dull market. The preferred has sold lower than ever at 117. The bonds fell off to 103⅞ from 104 for small lots.

Westinghouse has passed another quiet week, and the sales have been very light indeed. Maintained at the present figures it gives evidence as usual of good backing, and the present price will no doubt be exceeded on a good market. The sales show a fractional loss, but the price has been practically maintained, and it is strong at closing.

Bell Telephone has remained at its top price of 208, and shows no signs of weakening. All the telephone stocks are likewise strong, and prices are above the average.

Detroit Electric continues at 5 to 5½ with few sales, and nothing new reported to return the stock to its former figures.

West End Railway is active, and as usual there is but one idea on it, and that is favorable, and it is always sure of support on any market.

The Metropolitan Telephone and Telegraph Company, of New York City, through the Mercantile Trust Company, its trustee, invites proposals for the sale to the company of its bonds issued under the mortgage dated May 4, 1888. The sale is to be made on Jan. 3, 1893 to an amount not exceeding $10,000, at a rate not exceedieg par and 10 per cent. premium.

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8¾	9
Thomson-Houston Elec.—Series D.....	sh	120,000	8	7⅞	7⅞	8
Thomson Elec. Weld.. ...	100	1,000,000	....	....	....	....
Thomson European Elec. Weld.....	100	1,500,000	....	....	10	12
Westinghouse Elec.—New Com.	..	6,000,000	32½	38½	38½	39
Westinghouse Elec.—Pfd.	..	4,000,000	50¼	49½	49	50
General Electric.....	..	30,067,200	116	115¼	115¼	115½
" " Pfd ...		4,136,300	117½	117	117½	118
Fort Wayne Elec.....	25	4,000,000	12⅝	12½	12½	12¾
Fort Wayne Elec.—Ser. A.	sh	80,000	....	....	7⅞	8
Detroit Elec.....	20	750,000	5½	....	5	5½
West End St. Ry. Co.—Com	50	7,150,000	72¾	72⅛	72⅛	....
West End St. Ry. Co.—Pfd	50	6,400,000	87½	87	....	87½
American Bell Tel	100	15,000,000	208	207¼	207½	208
Erie Tel. & Tel. Co.....	..	4,800,000	47	....	46¾	47
Mexican Tel. Co.....	10	1,280,000	1.05	1.	1.	1.10
New Eng. Tel. & Tel. Co..	..	10,304,600	61	60	60	61
Tropical Tel. Co.....	10	400,000	....	....	....	10c.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stock furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.
Chicago.....	214	....
Central Union	....	58

Electrical Stocks:	Bid.	Ask'd.
Chicago Arc Light & Power Co.....	102	104½
Chicago Edison Co ...	165	..

NEW INCORPORATIONS.

The Grangeville Mill and Power Company, Limited, of Grangeville, Ida., capital stock $5,000, has been formed to construct and operate mills, electric plants, etc. J. P. Volmer and W. Scott, both of Grangeville, are interested.

The Keystone Fuel Gas Company, of Williamsport, Pa., capital stock $100,000, has been organized to supply heat by means of manufacturing gas in that town. G. Hess, P. B. Shaw, W. H. Cloan, all of Williamsport, are the promoters.

The Shoshone Falls Electric Power and Irrigation Company, of Chicago, Ill., capital stock $25,000,000 to develop water for irrigation, power and light purposes, etc. Nelson W. Perry, H. C. Baker and John B. Schmalz are the incorporators.

The Valley Passenger Railway Company, of Scranton, Pa., capital stock $200,000, has been formed to construct and operate an electric railway in Lackawanna county. John J. Fahey, Jas. O'Brien and M. W. Collis, all of Scranton, are interested,

The Mount Taba Water, Light and Power Company, of Sedalia, Mo., capital stock $3) 000, has been incorporated to construct and maintain water works and to furnish electricity for light and power. M. L. Andrews, B. F. Rosse, and D. E. Kennedy, of Sedalia, are the parties interested.

The Hyndman Electric Light, Heat and Power Company, of Hyndman, Pa., with a capital stock of $15,000, has been formed to supply light, heat and power by electricity. Geo. M. Hoblitzell, John K. White and John S. Weller are the promoters.

The Lansing City Electric Railway Company, of Lansing, Mich., capital stock $100,000, has been formed to construct an electric street railway in that city. Adam Gordon Norvie, New York City; Gordon Macdonald, New York City, and C. H. Osband Lansing, Mich., are the promoters.

Special Correspondence.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Nov. 3, 1892.

The Boston Braid Manufacturing Company is meeting with marked success in the sale of its silk braid for filament purposes.

The Beacon Vacuum Pump and Electrical Company, is making a handsome exhibit of its various styles of incandescent lamps at the Mechanics' Fair.

The American Circular Loom Company, Boston, Mass., the manufacturers of canvas jacket insulated wires and cables, is rushed to fill the recent orders.

The Safety Brake Shoe and Construction Company, Boston, Mass., report that its shoe is now being used by 30 street railways and is giving entire satisfaction.

The Massachusetts Electrical Engineering Company has on hand several large contracts in its particular kind of work, and reports that business is steadily on the increase.

Mr. Geo. M. Bobb has recently succeeded Mr. D. E. Washburn, and announces that he will carry a full line of electrical supplies. His address is the same as the old concern, 13½ Bromfield street, Boston.

The electrical display on the Shuman Building, which attracted so much attention on Columbus Day, and which was so appropriately and tastefully arranged, was the work of Messrs, Swan & Lane, Boston.

C. S. Knowles & Co., Boston, Mass., are making a specialty of insulating paper for electrical purposes; they are also New England headquarters for the celebrated Hoyt belting, and the R. Thomas & Sons Co.'s porcelan electrical specialties.

The American Nut Lock Company, of Worcester, Mass., has recently equipped its factory. This nut lock is strongly recommended for use on the motor equipment of electric cars, where a considerable shaking motion is experienced, which is likely to loosen the ordinary bolt.

Mr. Thomas H. Bibber, lately of the Consolidated Electric Manufacturing Company of this city has been appointed general manager of the American Magnetic Electric Company, with offices in the Boston Button Company's building on A street. Mr. Bibber has a large acquaintance in New England and is favorably considered by the electrical fraternity, and will undoubtedly make a success in his new connection.

The Citizens Gas and Electric Light Company, of Reading, South Reading and Stoneham, Mass., has brought a petition in equity in the Supreme Court of Middlesex County to compel the town of Wakefield to buy its electric and gas light plant and for the appointment of commissioners to determine the price to be paid. This case was the first one brought in this State under the Act of 1891, authorizing towns to manufacture their own gas and electricity and to purchase plants for the same.

The Edison Electric Illuminating Company, of Boston, is out with a notice to the public which reads as follows: "The U. S. Circuit Court of Appeals for the second circuit, a court of last resort, having rendered a decision fully sustaining the claims of Thomas A. Edison as the original inventor of the incandescent lamp now in common use, the public in general and all present users of such incandescent lamps in particular, whether burning on isolated plants or on the circuits of any other company, are hereby notified that the above company is the sole owner of all such inventions for the City of Boston, and that the sale or use of the same without the express consent of said company is hereby prohibited in said city, and further, that any such sale or use without such consent will render the person or corporation using the same liable to actions for damages on behalf of this company."

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Nov. 3, 1892.

Mr. Frank R. Ford has been appointed agent of the Short Electric Railway Company at Chicago in place of Mr. Alex. Kempt resigned.

The Strowger Automatic Telephone Exchange issued invitations last week to the installation of its first system at Laporte, Ind., on Nov. 3. A special train from Chicago carried those who were interested in the exhibit.

The Auditorium in Darkness.—A slight fire in the kitchen of the auditorium destroyed the insulation and short-circuited the electric light mains, blew the fuses and left the entire building in total darkness. The damage was only about $500, but it required some time to put the wires in working order again.

The Council Committee on Streets and Alleys has referred the ordinance granting the Chicago City Street Railway Company the right to substitute electricity for horses on several South Side streets to the corporation counsel for an opinion on the ability of the council to change the motive power without consent of the majority of the frontage.

Taylor, Goodhue & Ames are pleased with the success which has already attended their efforts, although they have been in the field less than a month. They have secured the general selling agency for the Nutting Arc Lamp suitable for all circuits and the well known Burton Electric Car Heater. They also have secured a large selling territory for specialties made by the Wagner Electric Manufacturing Company and the Columbia Incandescent Lamp Company. One of their recent acquisitions is the General Western agency for the Philadelphia trolley, which made so favorable an impression upon practical men at the recent Cleveland convention.

CANADIAN NOTES.

OTTAWA, Nov. 2, 1892.

Ottawa, Ont.—There is a project on foot for establishing an electrical institute in connection with the Ottawa University.

Montreal.—A number of capitalists are seeking to incorporate the Central Electric Company, of Montreal, Limited, with a capital of $200,000.

The Cortland Electrical Manufacturing Company, of Toronto, is seeking incorporation, with a capital of $40,000, to manufacture the Harvey Cortland patents.

Peterborough, Ont.—A meeting of the Peterborough & Ashburnham Street Railway Company was held last week, when Jas. Stevenson, M. P., was elected president and A. Stevenson secretary and treasurer.

The New Glasgow (N. S.) Electric Company has asked the Council to approve of a route for the proposed electric street railway to extend from Trenton to the Intercolonial Railway station, which will be eventually extended to Stellarton.

St. John, N. B.—Mr. Charles D. Jones, vice-president and managing director of the Consolidated Electric Company, states that a portion, if not the whole, of the street railway will be operated by electricity this fall. Work, with that end in view, is now being pushed vigorously.

London, Ont.—The city council has concluded an agreement for an electric street railway service. London already has a horse car road, The London Street Railway Company. The offer for an electric service is made by a new company which asks the right to run on streets not used by horse cars.

The Electric Car Company, of Ottawa, Ont., has given an order to W. W. Wylie, car builder, for six new vestibule cars and one sweeper, and Ahearn & Soper have given the same manufacturer an order to build 12 vestibule cars and 5 sweepers. The total value of 18 cars and 6 sweepers is about $50,000.

St. John, N. B.—Chas. D. Jones, vice-president and managing director of the Consolidated Electric Company, says that the electric cars will be in operation over at least a portion of the road this fall. The wires are now nearly all strung and sixteen motors have arrived from Washington, and these will be fitted on the cars at once.

Kingston, Ont.—The conclusion reached by the City Council is (1) that the Kingston street railway company will be required to lay down a track, and operate cars thereon, on streets not now oc-

cupied by the railway, and (2) that if the request is not obeyed in six months the council will be at liberty to deal with outside parties.

Parr's electric dry house at the Caudere, Ottawa, is just about completed, and the electric apparatus for it is now in the course of construction. It will be the first building in existence used for the purpose of drying lumber by electric heat. It is somewhat of an experiment, and Mr. Parr is to be congratulated upon his enterprise.

Ottawa, Ont.—The Electric Railway Company has abandoned the idea of heating the cars with hot water, owing to the necessity of keeping the electric power on all night to prevent the water from freezing. The hot water coils have been taken out of the several cars that had them in, and instead the Ahern electric dry air heaters will be used.

Halifax, N. S.—H. M. Niles, of Boston, auditor of the Edison General Electric Company; Mr. Moor, of New York, who is also connected with the same company, and J. A. Grant, of Boston, a director of the Halifax Illuminating and Motor Company have been in the city with a view to putting in an electric street railway in place of the present horse car system.

British Columbia.—S. H. Green, F. E. Coy and B. H. Lee have given notice that they will apply at the next session of the legislature for incorporation under the name of the Kaslo City Electric Light and Power Company, Limited, for the purpose of erecting and maintaining electric works and establishing an electric system in and about Kaslo City, in the district of West Kootenay.

William H. Boomer, proprietor of the Windsor (Ont.) Horse Car Line, is negotiating with Detroit capitalists for an extension of the line. If negotiations now pending are carried out, $50,000 of new capital will be added, the line extended on the east to the wine house above Walkerville and on the west to Michigan Central depot, and the road equipped with one of the finest electric systems in the country.

The Quebec & Levis Electric Light Company, of Quebec, which has its generating plant at Montmorency Falls, has purchased from the Hall estate, for $235,000, the water power of the falls and the mills and the buildings on both sides of the river immediately above and below the cataract. Hitherto the company were paying a rental of $5,000 a year for the use only of a portion of the water power.

Hamilton, Ont.—At a meeting of the projectors of the Hamilton, Waterdown & Guelph Railway the necessary cash for all expenses in connection with the charter and preliminary proceedings was put up and $50,000 worth of stock was subscribed. The company will have a capital of $500,000. The men who are pushing the scheme are evidently in earnest, and the work will be pushed through very quickly.

Walford, Ont.—Much interest is manifested by residents of Walford, Arkona and Thedford in a scheme to connect these places by an electric railway. A representative and enthusiastic meeting was held at Arkona on Sept. 21. The meeting was largely in favor of the building of the road, the estimated cost of which is $60,000. All the stock has been subscribed, and the promoters expect to have the line in operation in a short time.

Lethbridge, N. W. T.—A meeting of the citizens was held last week to consider the advisability of starting a local company for the purpose of supplying the town with electric light. A motion was carried that a joint stock company be started in town with a capital of $25,000 to operate the business of an electric lighting and power company in the town of Lethbridge, and that a committee of five be appointed to open up a stock book.

Toronto.—The change of the telephone system in connection with the Bell Telephone service in this city will cost half a million dollars. This year's appropriation was $100,000. Already more than that has been expended. A hundred men are busied all the time stringing or laying the double wires for the new circuit. Three branches have been opened, one at Yorkville, equipped to accommodate 3,000 subscribers, one at Parkdale for 2,000, and another at Toronto Junction of the same size.

Kingston, Ont.—The Kingston Street Railway Company is not inclined to surrender its right to a perpetual lease of the streets, but offers the city a percentage for the use of the streets where the gross earnings annually reach $30,000. On this three per cent. per annum would be allowed, on $40,000 four per cent., on $50,000 five per cent. and on $60,000 six per cent. Mr. Folger says that if the road does not pay $30,000 annually it would not be safe for a company to invest $100,000 in it. If the terms are adopted he would be willing to allow a director to act on the executive board of the company.

Nanaimo, B. C.—According to the *Free Press* arrangements are being perfected for the formation of a joint stock company to take over and run the electric light plant and works. Several improvements are to be added, and a thoroughly capable manager placed in charge. A rumor has been afloat that since the prospects for the city purchasing the plant are at an end the works are likely to be removed, and the city may have to return to gas for street lighting. Later information says that the electric light works will beput under the hammer on Saturday next, without reserve, subject to the present incumbrances. The auction will take place at the works on Fraser street.

News of the Week.

THE TELEPHONE.

The Great Southern Telephone Company has decided to construct a telephone line from Vicksburg, Miss., to Yazoo City.

Troy (N. Y.) Telephone and Telegraph Company is replacing its iron wire between Troy and Albany with a complete copper circuit.

The New England Telephone Company has connected its line between Rutland, Vt., and Vergennes, which completes the circuit from Burlington to Boston.

The Chesapeake & Baltimore Railroad Company, of Baltimore, Md., is disregarding the spirit if not the letter of the telephone bill passed by the legislature last winter. It has refused to accept the legally prescribed rental which the customers have tendered and claims that it is still entitled to the old rates for the regular service, and that the rentals determined upon by the legislature only entitled the subscriber to a service so inferior as to be practically worthless.

THE ELECTRIC LIGHT.

Rochester, N. Y.—The recently formed Citizens' Light and Power Company have been granted street and pole privileges by the Common Council. Wires are required to be underground on the main streets. The generating station will be located on Brown's Race, on the site of the mills which were destroyed by the 'naptha explosion." The Heisler alternating system will be used.

Chesaning, Mich., is to have an electric light plant.

Spring Valley, Ill., is about to be lighted by electricity.

Bath (N. Y.) has unanimously accepted its electric light plant.

West Newton, Pa., is inviting proposals for an electric light plant.

Tipton, Ind.—The electric light plant was recently burned at a loss of $12,000.

Millerton, N. Y., is to erect an electric light plant at a cost of between $6,000 and $7,000.

Port Chester, N. Y., is making efforts to organize an electric light company and to secure a plant.

The Hyde Park Electric Light Company, of Hyde Park Pa., has made an application for a charter.

Springfield, O., contemplates the construction of an electric road from that city to Clifton, and has secured an option on the right of way.

The Batavia (N. Y.) Board of Aldermen at a special meeting decided to advertise not only for propositions to furnish a plant but for street lighting by private corporations.

Canton, China., is to have electric lights. There is a great opposition on the part of the natives but it is now stated that all obstacles have been removed. If this system is successfnl an electric street car line will be built and a telephone system introduced.

Easton, Pa.—At a meeting of the newly elected directors of the Edison Illuminating Company, the board organized by the election of the following officers: President, J. T. Knight; vice-president, N. P. Cornell; secretary, treasurer and general manager, Howard Rinek.

The West Shore Mills Company, Astoria, Ore, is constructing a new power-house 100 feet square to use for an electric light and power station to be used for day and night service. A 20 × 52 Hoffman & Billings Corliss engine with an 18-foot fly wheel grooved for transmission is supplied with steam by an 8 × 14 marine boiler and a 5 × 16 foot boiler with a brick furnace. Two 50-light Thomson-Houston arc machines and two alternating incandescent machines of 650 and 1.000 lights capacity of the same make, form the electrical equipment.

THE ELECTRIC RAILWAY.

The Electric Road Between Warren (O.) and Niles is to be built, and the contract calls for its completion by Christmas.

The Oakland (Cal.) Consolidated Company has placed air brakes on its electric cars, and the experiment has proved a great success.

The Lake Roland Elevated Railway Company will build a two mile extension through private property to the shore of Lake Roland, where land has been secured for a park.

Mr. Harlan Wellman has been appointed superintendent of the Ashland & Catlettsburg Electric Railway Company, with headquarters at Ashland, Ky. A seven mile road is under construction and is to be equipped with Westinghouse apparatus.

St. Louis (Mo.) Council Committee on Railroads is considering two important street railway bills, one of which contemplates the connection of the extreme northern end of the city with the extreme southern by means of an electric road.

The Union Electric Railway, New York City, has now been running some time and with entire success. Seventeen minutes is saved each way on the trip, which formerly took 47 minutes; 26 cars are now in operation, and have run thus far without an accident of any kind.

It is reported that a deal is being made by which the Baltimore Traction Company will become the owners of all the lines belonging to the city and suburban railway companies, the price being $1,700,000. Both parties deny the truth of the report, but it is generally believed to be a fact, since the Traction company has tried before to gain possession of the above named system.

The City and Suburban Railway Company has secured a site for its power station. The lot is 140 feet wide fronting Pratt street, and 200 feet deep on O'Donnell's and Dugan's wharves. The S. D. Warfield Company are the engineers in charge, and they will shortly begin work on the station which will cost $500.000, and supply current to six lines now owned by the city and suburban companies.

The San Antonio Street Railway Company, of San Antonio, Tex., which owns the street railway system of that city, consisting of thirty-five miles of tracks, has been fully reconstructed as an electric railway. It is now carrying over 8,000 passengers daily, and its net income, after paying operating expenses and taxes, is now about $55,000 per annum and steadily increasing. This company has just completed arrangements with N. W. Harris & Co., bankers, of Chicago and Boston, for a loan of $450,000 to pay off all its prior indebtedness, principally incurred in the electrical equipment of its system.

The Roanoke (Va.) Street Railway has thus far a very successful record. Construction on six and a half miles of the road was begun on July 4, 1892, by General Manager W. F. Carr, to whom great credit is due. Seven cars, five of them built by the Gilbert Car Company, of New York, and two equipped with Brill trucks, are now in operation. Five Westinghouse, two Edison and one Thomson-Houston motor equipments are used, and after three months operation have never given the least trouble. Edison generators, driven by Armington & Sims engines, furnish current to the line, while the lighting equipment consists of four C. & C. 750-light incandescent and two Edison 450-light incandescent machines, driven by two 125 Buckeye and one 100 Taylor-Beck engines. The total capacity is 2,000 16-c. p. incandescent and 125 Ward arc lights. The boilers are from the Bridge and Iron Company, of Roanoke. The travel on this road has increased 20 per cent. since the introduction of electricity. Mr. E. R. Kitridge, the electrician, is deserving of great credit for his part in the work.

LEGAL NOTES.

Compensation for Extra Time Under Eight-Hour Law.—Under a statute providing that eighth hours shall constitute a legal day's work, but permitting overwork by agreement for an extra compensation, where one accepts a position knowing that he will be expected to work more than the statutory time, his consent to his employer's requirements will be presumed, if he continues to work without objection or giving notice of an intention to charge for extra time, and he cannot recover for the time in excess of eight hours a day during which he worked. Such a statute applies only to cases where the employment is by the day.—(Helphensteine v. Hartig, Apellate Court of Indiana, 31 N. E. Rep., 835.)

Federal Telegraph Franchise Cannot Be Taxed by State.—The United States Statutes provide that any telegraph company by filing the written acceptance, may construct and operate lines over any portion of the public domain, across any navigable water, and along any of the military or post roads of the United States; that the United States shall have priority in sending telegrams between the departments of government, its officers and agents, at rates to be fixed by the postmaster general; that after five years the United States may purchase such lines for postal and military purposes at an appraised value. A telegraph company, by filing such acceptance, acquired national franchises, which no State could tax.—(City and County of San Francisco v. Western Union Telegraph Company, Supreme Court of California, 31 Pac. Rep. 10.)

MISCELLANEOUS NOTE.

The First Electrolier.—The first fixture to which the word "Electrolier" was applied was manufactured by B. Varity & Sons, King street, Covent Garden, London, for Mr. Edison's exhibit at the Crystal Palace, 1882. It is in this and other respects a curiosity, as it is one of the largest pieces of hand-wrought floral work that has ever been manufactured. It stands about 16 ft. high and is 10 ft. broad, has 99 lights in three circuits, and originally cost over £350. It is now offered for sale by B. Verity & Sons for £75, the metal alone in it being of considerable value, and that firm has suggested that perhaps some of the prominent companies who propose making brilliant displays at Chicago might feel disposed to utilize it "as the first electrolier that was ever constructed."

Industrial and Trade Notes.

The Fraklin Electric Company, 106-108 Liberty street, New York City, has been obliged to enlarge its plant and increase its force on account of the many orders it has lately been receiving.

August Wolf & Co., Chambersburg, Pa., is sending out a new pamphlet on the well-known Wolf-Keiser turbine water-wheel, which contains detailed information concerning the construction and operation of this wheel.

Thos. Yearsley, 123 North Third street, Philadelphia, reports that during the past week the company has sold one 50-light arc, one 15-light arc and two 300-light incandescent dynamos, one 15-h. p. and two 3 h. p. motors with all necessary supplies.

The Colburn Electric Manufacturing Company, Fitchburg, Mass., has issued a neat little pamphlet describing its electric generators and motors. These machines are of very neat and compact design, and practical experience has proved that they are efficient and economical.

The Albany Lubricating Company, 313 West street, New York City, reports large orders from Mexico and other southern ports. The Albany grease has found great favor with electric light plants, and the company is now fitting some very large Edison dynamos with its grease cups.

Putnam, Gay & Co., Rochester, N. Y., was dissolved on Oct. 29. The business will be conducted hereafter under the firm name of J. E. Putnam & Co. Mr. E. A. Gay has opened an office in the new Berkley building on Clinton street where he will handle electrical supplies and specialties.

The Brush Electric Company has just completed the installation of a 30-arc light plant at the factory of Benedict & Burnham, Waterbury, Conn., and a 60,000-watt Brush alternating plant at Cornwall on-Hudson, N. Y., both of which plants were recently sold by Mr. A. D. Dorman of the New York office of the Brush company.

The Edison-Lelande Company, 110 East Twenty-third street, reports business as very active. The company is getting out something new in the line of ampère-meters and static voltmeters and also surgical and dental outfits. The character of the apparatus handled by this company is too well known to need any word in its favor.

Some facts of interest in regard to the Sargent automatic smoke preventer are given in an attractive pamphlet which has recently been issued by Sargent & Greenleaf, Rochester, N. Y., and which should prove of interest to managers of electric light and power stations and other concerns that have been troubled more or less with the smoke nuisance.

Among the recent shipments of Reliance Safety Water Columns by The Reliance Gauge Company of Cleveland, O., were eight No. 5 to the Standard Oil Co., Constable Hook, N. J. The Standard began using the columns in 1884. Orders were also recently given by the Supervising Architect for the immediate equipment of all boilers in the U. S. Treasury Department at Washington, not already equipped with Reliance columns. Twelve more columns were recently shipped to the Philadelphia & Reading Coal and Iron Company, which uses them on all new boilers put in, both in the mines and along the road.

Some Handsome Catalogues.—We have received from the Westinghouse Electric and Mfg. Co., Pittsburgh, Pa., a set of catalogues which exhibit in detail the construction of the electric railway apparatus of that company. One of these deals with the railway apparatus in general and contains information on the single reduction motor; another treats of armatures, their construction and care; while a third gives testimonials from the managers of street railway companies using the Westinghouse apparatus. It is unnecessary to say that in every instance the operation has been entirely satisfactory.

The Ball Engine Company, of Erie, Pa., reports the following recent shipments of engines: General Electric Company, Atlanta, Ga., one 150 h. p.; Lake Shore Iron Works, Marquette, Mich., one 60 h. p.; Risdon Iron Works, San Francisco, Cal., one 25 h. p.; Badenoch Bros., Englewood, Ill., one 600 h. p.; Calvert Building and Construction Company, Baltimore, Md., one 80, one 130 and one 35 h. p; Excelsior Electric Company, Port Huron, Mich., one 400 h. p.; F. R. Dravo & Co., Pittsburgh, Pa., two 80, one 100 and two 25 h. p.; Crook, Horner & Co., Baltimore, Md., two 80 and one 60 h. p.; J. H. Kuebling, Washington, D. C., one 60 h. p.; Risdon Iron Works, San Francisco., Cal., one 150 h. p.; General Electric Company, New York City, two 100 h. p.

The Sub-Division of Power.—The sub-division of power in large manufacturing establishments (by which is meant the substitution of several small engines in place of one large engine, and the distribution of power in the form of steam rather than by shafts and belts,) has been a matter of active discussion of late. Originally looked upon as an experiment which might show against the fuel account, it was some time in gaining the confidence of manufacturers, as well as of engineers. The most persistent advocates of sub-divided power, as engineers, have probably been Messrs. Westinghouse, Church, Kerr & Company., and many important plants have been designed by them on this basis. When the great Spreckels sugar refinery was built, some four years ago, and it was announced that Chief Engineer Watson and his asso-

ciates had finally settled upon the radical departure of sub-divided power throughout, many conservative engineers doubted the wisdom of an experiment upon so large a scale, and involving a position from which there was no line of retreat nearer than a complete reconstruction of the plant. Not only was the sub division of power so completely carried out as to involve over 60 engines distributed on every floor of the enormous building, and practically doing away with shafts and belts altogether, but high-speed engines were selected, and most of them set without foundations. Non-compound engines were employed, from the fact that the various processes utilized all the exhaust steam which could be made This refinery has since passed into the ownership of the American Sugar Refining Company, and further enlargements are now in progress. The experience of three years of operation, literally night and day, was brought to bear upon the question of future extension of power, and the decision may be taken as significant of the general result obtained. An order has just been placed with M. R. Muckle, Jr., & Co., of Philadelphia, for five more Westinghouse "Standard" engines, four of 100 h. p. and one of 75 h. p., making 68 engines now operating in this refinery. A similar sub-divided plant, involving 42 engines, was installed at the print works of the Dunnell Manufacturing Company, Pawtucket, R. I., and its chief engineer reports that the total repair bill for the first year of continuous operation was less than three dollars.

Business Notices.

Transformers rewound and repaired. Write for prices. The Hill Manufacturing Company, Salem, Va.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Are You With Us?—We defy any oil saving or purifying device manufacturers to produce an apparatus that can compete with the Ideal Steam Oil Refiner, made by the Purity Oil Filter Manufacturing Company, 900 Water street, Pittsburgh, Pa.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

U. S. PATENTS ISSUED OCT. 25, 1892.

485,181. Dynamo; William H. Elkins, Cambridge, Mass. Application filed Oct. 7, 1891. A dynamo-electric machine having two sets of brushes on its commutator, a set of field coils connected to one set of brushes and to the work-circuit, and a set of field-coils connected between two sets of brushes, the two sets of coils having substantially equal ampere turns under full load.

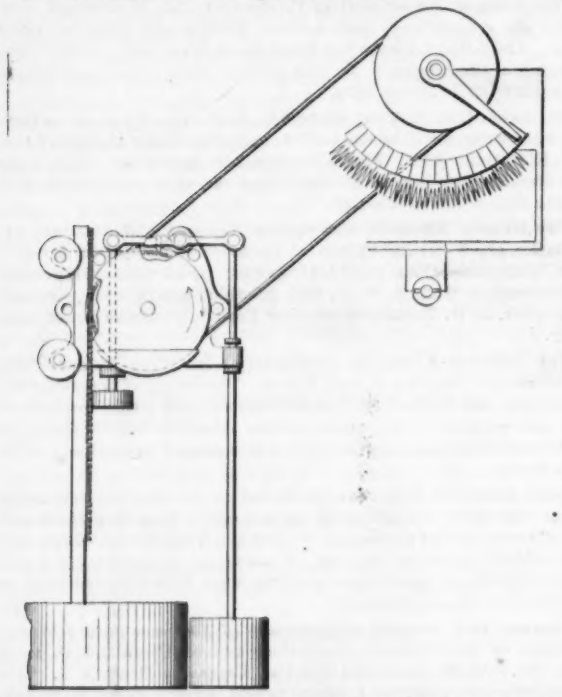
485,220. Dynamo-Electric Machine; David Pepper, Jr., Philadelphia, Pa. Application filed March 28, 1892. In an armature ring, sections adapted to abut at the ends and form the ring, and each section having an inwardly-extending arm or spoke, the end of which is adapted to extend around and grasp the armature-shaft on the side farthest from the section.

485,221. Automatic Device for Electric Pumps, Francis A. Pocock, Lynn, Mass Application filed March 20, 1891. The combination, with an electric pump or similar mechanism, of a starting and stopping device therefor, a float connected with, and serving to operate the starting and stopping mechanism and locking devices controlled by a rising and falling liquid at a determined high and low level respectively. (See illustration.)

485,238. Device for Treating Patients by Electricity; Edmund M. Thomas, Little Rock, Kan. Application filed April 6, 1888. In a regulator for constant current, means for taking current from a section only of the armature-winding, irrespectively of the main current connections, a device responding to the current so taken up, and electromagnetic mechanism controlled thereby for shifting the brushes of the machine connected to the main circuit to positions on the commutator at which constant currents are taken up.

485,252. Underground Electric Trolley System; Ruben B. Ayers, New York. Application filed March 23, 1892. In an underground electric trolley system, a supporting frame for the trolley wire, having an upward extension so as to admit a trolley wire, and a ring embracing the spring.

485,256. Apparatus for Winding Wire; Frank B. Chase, Chicago, Ill. Application filed Jan. 4, 1892. This device consists of the combination of a support with the ribs at either end, a wire securing device on these ribs, arranged so that wires may be stretched from rib to rib and arranged in parallel groups in the same plane with and in close proximity to each other, and a groove across such bridge, whereby the wires may be conveniently cut at the ends when the process is completed.



No. 485,921.—Automatic Governing Device for Electric Pumps.

485,279. Combined Telegraphy and Telephony; William W. Jacques, Newton, Mass Application filed April 8, 1892. The combination, with a telegraph apparatus and an electrostatic inductive resistance, and an electromagnetic inductive resistance.

485,284. Armature Core for Electric Motors and Dynamos; Anton J. Lehman, New York. Application filed Jan. 30, 1891. An armature core for motors, dynamos, or electromagnetic machines, composed of magnetic gauze, cloth, netting or the like, rolled upon itself, the meshes of which are filled with a paste composed of any magnetic powder, combined with a binder, the last or peripheral layer or layers of which are bent at an angle to form lugs or arms that project.

485,287. Electric-Lighting System; William M. MacKay, Roanoke, Va. Application filed June 13 1892. In combination with a railway line or circuit, another circuit branching therefrom, and comprising wires, electrodes, a coil and lamps, an electromagnet, an armature provided with a plate, and the local circuit and switch.

485,293. Electric-Arc Lamp; John A. Mosher, Chicago, Ill. Application filed Jan. 2, 1892. In an arc lamp, a spring contact and a carbon rod provided with a fiber plug with a portion extended beyond the end of the rod and of greater diameter than the rod, and having a circumferential groove above the end of the rod.

485,311. Telephone; Anthony C. White, Boston, Mass. Application filed March 21, 1892. In a granular button for a transmitting telephone, the combination with a heavy chambered block of electrodes and finely divided conducting material, of a mica spring disc carrying an electrode and confining the granulated material within the chamber in the lock.

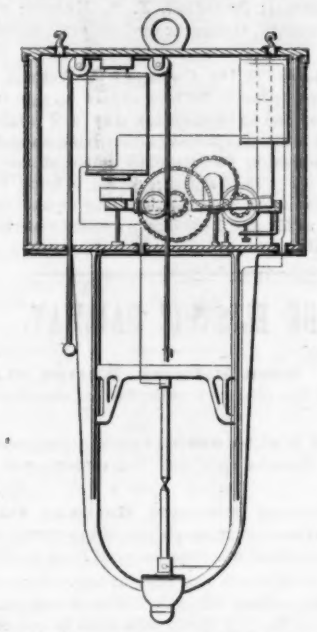
485,319. Galvanic Battery; Walter Ambus Crowdus, Memphis, Tenn. Application filed Dec. 18 1891. In a galvanic battery, a battery case provided with metal rods extending through it from top to bottom and connected at their bottom ends to the respective electrodes of the battery.

485,327. Electric Arc Lamp; Edward R. Knowles, Middletown, Conn. Application filed Nov. 24, 1891. In an electric lamp, a train of gearing, a frame for supporting the same, a vertically moving perforated flexible ribbon or band engaging with the train of gearing and supported on the frame of the lamp, and a roller pivoted in the gearing frame and in contact with the perforated flexible band or ribbon, whereby it is kept in engagement with the train of gearing and prevented from slipping therefrom. (See illustration.)

485,334. Electromagnetic Telegraphic Apparatus; Alfred G. Safford, Washington, D. C. Application filed March 16, 1892. In electromagnetic telegraph apparatus operated by intermittent impulses from the transmitting station, a reciprocating armature limited in its motions by stops and provided with a permanently attached core of an electromagnet in opposition to the electromagnet, and inductive cross piece in opposition to the electromagnet.

485,336. Self-Induction Device; William Stanley, Jr., Pittsfield, Mass. Application filed April 10, 1891. The combination of an annular laminated magnetic core, a continuous magnetizing coil, the sections of which are wound through perforations in the core, a circular series of contact-plates to which the sections are looped, and a contact lever for including more or less of the sections in a circuit of alternating currents.

485,337. Circuit Switch; Marvin E. Sullivan and John Doss, Denver, Colo. Application filed April 2, 1892. The combination, with a main circuit of a switch consisting of an insulating base, two contacts secured to the base and to which the mains from



No. 485,327.—Electric Arc Lamp.

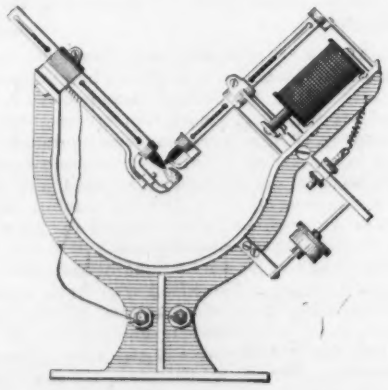
the dynamo respectively lead, arms pivoted in the contacts, two other contacts, to which the main circuit terminals lead and with which the pivoted arms are connected when the current passes through the entire main circuit, and two or more intermediate contacts adapted to be engaged by the pivotal arms when shifted, and branch contact wires leading from different parts of the main circuit to the intermediate contacts.

485,347. Electric-Arc Lamp; Henri Japy, Beauscourt and Oscar Helmer, Paris, France. Application filed March 22, 1892. The combination of sliding carbon carriers, a flexible drive chain attached at each end to one of the carriers, a toothed motor-wheel over which the chain passes directly from said suspensories, a clock movement geared to the wheel and carrying the clock movement, an escapement lever adapted to engage a stationary serrated surface, and means as indicated, oscillating the frame to release the escapement.

485,351. District Alarm Box; Charles Woodford McClellan, Chicago, Ill. Application filed Aug. 1, 1891. The combination, in a district alarm box, with a clock work spindle and arm closed to an electrical circuit, of segmental plates surrounding the spindle, but insulated therefrom and from each other, with one or the other of which the arm is always in contact, the main wire and loop wire respectively connected to the plates, and an electrically actuated signal closed to the loop-wire.

485,352. Electric Signal; George McIntosh. Stonington, Conn. Application filed March 10, 1892. In combination, a signal, an electromagnet for operating this signal, an auxiliary electromagnet, a commutator, a motor for continuously moving the commutator, a source of electricity, an electric circuit complete through the signal operating magnet, and one of the circuit closers under the control of the auxiliary magnets, a second circuit complete through the auxiliary magnet and commutator, and a third circuit complete through the motor.

485,367. Electrical Door-Trip for Engine-Houses; Adam Bosch, Newark, N. J. Application filed March 14, 1892. In combination with the electromagnet and door catches and connecting rod, an armature lever having a hammer to engage the rod or bearing thereon, and an eccentric bearing for the spring.



No. 485,537.—Electric Arc Lamp.

485,379. Electric Bell; John Randolph Hard, New York. Application filed June 7, 1892. In an electric bell, the combination, with the casing, the magnet mounted therein, and the vibrating armature, of the armature spring secured to the armature at one end and to a fixed part at its other end, the tension regulating screw which bears on the spring, and a bearing for the spring arranged between the point of attachment of the latter to the armature and the point where the tension regulating screw bears thereon.

485,424. Electric Heater; Henry Gibson O'Neill, Louisville, Ky. Application filed Feb. 7, 1892. In an electric heater, the combination with a steatite heater-body and resistance wires, of a nonconducting cement whereby the wires are attached to the heater-body and covered for purposes of insulation and anti-oxidation.

485,425. Electric Intermutator; Henry G. O'Neill, Louisville, Ky. Application filed Feb. 9, 1892. This intermutator comprises a base, a rotary conducting shaft journaled on it in insulated bearings, a series of discs arranged at intervals along the shaft, the segments being arranged complementary to each other with a slight overlap, a brush contacting with each of the discs, an electric motor also supported on the base and having its shaft parallel with the conducting shaft, a gear-wheel on the motor shaft and on the conducting shaft, an intermediate insulated multiplying gear between the wheels, and a current supply for the conducting shaft and for the motor.

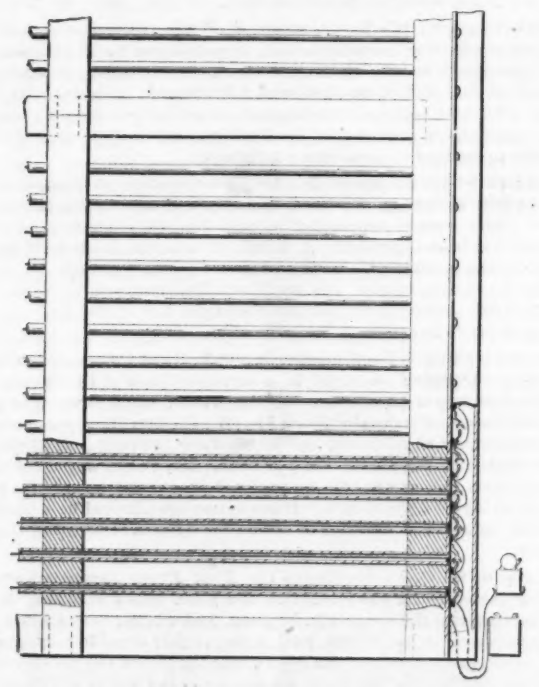
485,473. Electric Danger Signals for Moving Trains; James McCart and Arthur G. Judkins, Trenton, Mich. Application filed Sept. 26, 1891. This invention consists of the combination of continuous unbroken track conductors nominally in open circuit, the vehicle having vertically adjusted conducting rods mounted thereon, spring stems depending from these rods and having contact shoes on their lower ends, that bear on the track conductors, the circuit in the vehicle, in which is located a source of electricity and switch and which is connected with the vertically-adjustable rods, and the bell circuit in the vehicle, having a switch and adapted to be cut into and out of circuit with the contact-shoes independently of the battery circuit, whereby provision is made in the vehicle for sending and receiving a communication at any point on the track, whether the train be in motion or standing on the track.

485,478. Incandescent Electric Lamp; Edward Pollard, Cambridge, Mass. Application filed March 2, 1892 In combination with the filament supporting tube closed to form a seal, two bands or deposits of silver or other metal upon the tube, extending through the seal and forming an electrical connection between the filament and conducting wires.

485,506. Jail or Vault Construction; David K. Osbourne, St. Paul, Minn. Application filed Sept. 8, 1891. The combination, with a tube in electrical connection with one pole of an open circuit battery, of an insulated conductor supported within the tube and connected with the other pole of the battery. (See illustration.)

485,537. Electric Arc Lamp; Edgar A. Edwards, Cincinnati, O. Application filed Nov. 25, 1891. In a focusing electric arc lamp, the combination of a positive electrode and a positive electrode and positive refractory stop against which it normally rests, of a negative electrode and a detaining finger bearing against the electrode. (See illustration.)

485,555. Underground Electric Conduit and Trolley Bar for Electric Railways; John S. Moss, Martinsburg, W. Va. Application filed April 16, 1892. The combination, with a single casing having a longitudinal opening or slot, of a rubber formed integral with a pair of bollow compressible cushions which normally rest in contact with each other, a conductor support in the casing and a conductor arranged on the support.



No. 485,506.—Jail or Vault Construction.

485,558. Electric Switch; James O. O'Neil, Cleveland, O. Application filed Oct. 14, 1881. In an electrical switch, the combination, with a non-conducting cylinder, of a metallic strip on the periphery of the cylinder, at or near each end of it, a metallic strip on the periphery of the cylinder intermediate of its ends and electrically separated from the strips at the ends of the cylinder, brackets arranged at one side of the cylinder and carrying contact plates adapted to engage the end metallic strips, brackets at the other side of the cylinder, and two contact plates carried by each of the last mentioned brackets, one contact plate of each bracket being adapted to engage one of the end strips and the other contact plate of each bracket being adapted to engage the intermediate strip, whereby, when the cylinder is oscillated, all of the strips will be electrically connected by one set of contact plates before the other set engages or disengage any of these strips.

485,559. Construction of Jails; David K. Osbourne, St. Paul, Minn. Application filed Jan. 4, 1892. This invention consists of a tubular metallic structure, of an open circuit battery having one pole connected to the structure, a series of insulated cores arranged loosely in the tubes of the structure and connected to the other pole of the battery, and signaling devices included in the circuit.

485,587. Socket for Incandescent Electric Lamps; John S. Potter, Newton, and David J. Cartwright, Boston, Mass. Application filed Oct. 6, 1890. The combination of a block of insulating material impervious to moisture, recesses in opposite ends of the block, separated by a partition, one of the recesses being adapted to receive the base of the lamp and the other recess having the conducting wires cemented upon it by a waterproof insulating material, a block of hard rubber or other similar insulating material capable of holding a screw placed in the recess which receives the lamp and clamped to the partition by a screw, metallic contacts fixed to this block electrically connected to one of the conducting wires and adapted to make electrical contact with one of the filament terminals on the lamp, a metallic contact fixed in this block, insulated from the other contacts and electrically connected to the other conducting wire and adapted to make electrical contact with the filament terminal contacts in the centre of the base of the lamp, a filling of cement of a waterproof insulating material around the conductors in the other recesses.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y